FINAL ENGINEERING REPORT
FOR THE
AN/ALQ-131 BLOCK I AND BLOCK II TWT
SCREENING ANALYSIS

SECURITY CLASSIFICATION: Unclassified

RESTRICTED DATA: NONE

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EXECUTIVE SUMMARY

Traveling Wave Tubes (TWTs), broadband RF amplifiers, are used in the majority of the Electronic Warfare (EW) systems. Low power TWTs are used as driver TWTs, or pre-amplifiers, and relatively high power or output TWTs are used as transmitters. TWTs are high value items, and they are usually the single most expensive item in Electronic Warfare systems.

Significant quantities of TWTs are in storage at the Warner Robins Air Logistics Center (WR-ALC). Because of the time these tubes have been held in stores, there are concerns about the operational status of these depot assets. As a result of these concerns WR-ALC initiated contract F09603-86-G-3044 Task 0020 with the Westinghouse Regional Service Center (RSC) in Warner Robins to perform an impartial engineering screening program on serviceable AN/ALQ-131 TWTs. As the manufacturer of the AN/ALQ-131 Block I and Block II EW systems, Westinghouse had both the TWT and system background needed to develop the test criteria and perform the screening.

The goals of this program was to ensure that the TWTs operated properly when issued to a field shop and to create a quantitative data base which could be used to predict the serviceability of the AN/ALQ-131 TWTs remaining in depot stores. In addition, the test data base would provide some insight into the probable serviceability of other depot TWT assets.

To provide a comprehensive screening program system testing, using the AN/ALQ-131 pod and its support equipment, and laboratory testing, using TWT factory test equipment, were performed. The Westinghouse Regional Service Center had the equipment and personnel necessary to perform system testing. To perform the detailed TWT tests Westinghouse subcontracted with Teledyne MEC, a TWT manufacturer, to provide factory TWT test equipment and personnel to operate it and analyze test results. The factory test equipment consisted of an ETM Universal TWT Test Tool and an altitude hypot chamber. The ETM is an industry standard used to test TWTs. The tests performed on the ETM were validated using the AN/ALQ-131 field shop support equipment. This was the first time factory test equipment and field shop equipment were located in one laboratory, and the combination provided a unique opportunity to perform a controlled assessment of a TWT's performance and correlate the test results with system performance.

Between January 1990 and December 1990, a total of 1,046 AN/ALQ-131 TWTs were tested. The TWTs included tubes from the three frequency bands of the AN/ALQ-131 and from the major TWT vendors - Litton, Varian, and Teledyne MEC. There were 532 output TWTs and 514 driver TWTs. All the TWTs tested were classified as Condition A (serviceable) and there were both new and used TWTs in the sample. The new tubes were in the original, unopened manufacturer's shipping container. The used TWTs were previously fielded units which had been returned to storage as serviceable.

The pass/fail criteria applied to each TWT was as follows: TWTs that passed the ETM tests were classified as serviceable. The TWTs that failed the ETM tests were evaluated by a Failure Review Board (FRB) to determine if the type and degree of failure degraded system performance. Often the FRB would request that additional system testing be performed before reaching a decision. Tubes that passed the FRB review were classified as serviceable.

Of the 1,046 TWTs screened at the Westinghouse Regional Service Center, 707 (68%) were returned to Warner Robins ALC as serviceable (Figure 1), 145 (14%) were returned as unserviceable, and the decision on 194 (19%) is pending completion of shelf life study. All 194 TWTs that are pending investigation are Litton Band 5 driver TWTs.

Of the 532 output TWTs tested, 409 (77%) were classified as serviceable (Figure 2). Separated into new and used categories, 344 (89%) of the 388 new output TWTs were serviceable, and 65 (45%) of the 144 used TWTs were serviceable. A perveance (unstable gun) problem was experienced in the used TWTs. Refer to paragraph 8.2 for further details. Based on these results, when an output TWT is drawn from depot stock, nine out of ten new TWTs would be serviceable, and one out of two used TWTs would be serviceable.

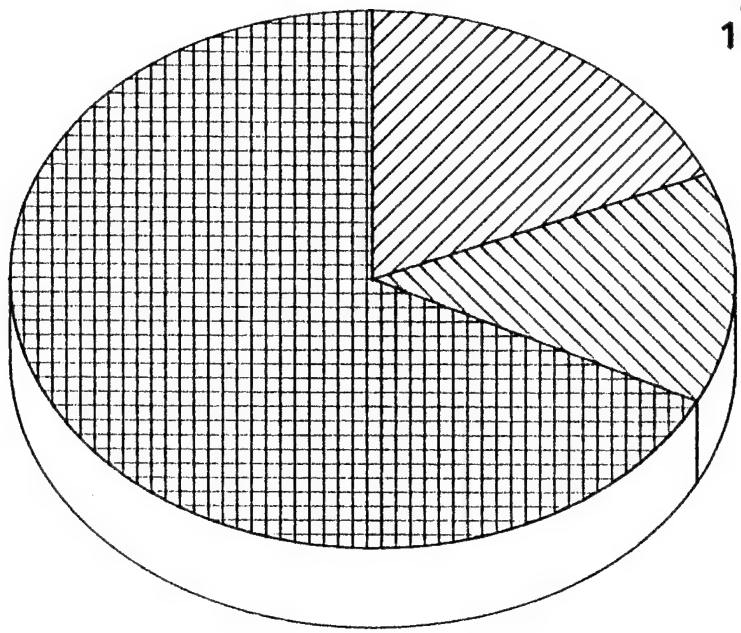
Of the 514 driver TWTs tested, 298 (58%) were classified as serviceable (Figure 3). One hundred ninety-four (38%) of the driver TWTs are being held to investigate a slow warm-up problem. Refer to paragraph 8.4 for further details. For new driver TWTs, 250 (56%) of the 450 tested were serviceable. Of the 64 used driver TWTs tested, 48 (75%) were serviceable. Based on these results a new driver TWT drawn from depot stocks would be serviceable 6 out of 10 times. A used driver TWT issued from supply would be serviceable approximately 8 out of 10 times. Other paragraphs in this report describe these statistics by frequency band, by vendor, and by types of failures.

The conclusions and recommendations resulting from the screening program are:

1. Three out of four output TWTs drawn from depot stock will be serviceable. A driver TWT drawn from depot stock will be serviceable on average 3 out of 5 times.
2. There is not an output TWT shelf life problem. The failure rate of the stored TWTs was not a function of time.
3. Vacuum leakage is not a problem. None of the TWTs tested were down to air (DTA).
4. Output TWT burn-in is important before use, but periodic burn-in during storage is not necessary.
5. Further investigation is required to determine the cause of the perveance problem found in Band 3 output TWTs.
6. Further investigation is required to resolve the Band 5 driver TWT warm-up problem.
7. A continuing program of screening and re-optimization of TWTs prior to shipment to the field will significantly reduce chances that a bad TWT will reach the field.

AN/ALQ-131 TWTs

Program Summary: Total TWTs Screened (Serviceable vs Unserviceable)

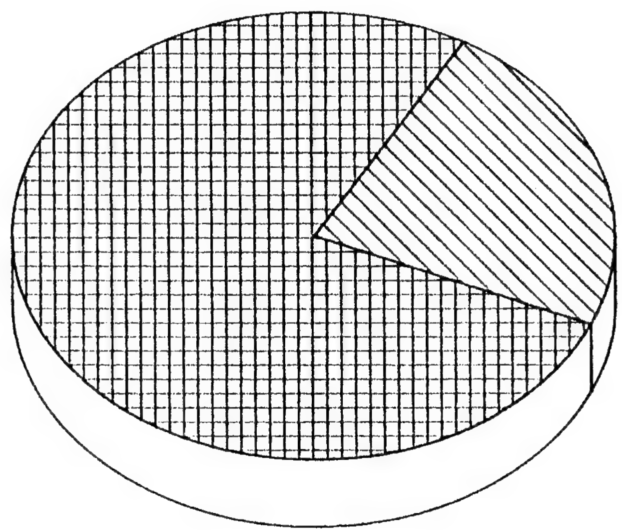


1046 TWTs Screened

Figure 1 (a)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Total TWTs Screened
(Serviceable vs Unserviceable)

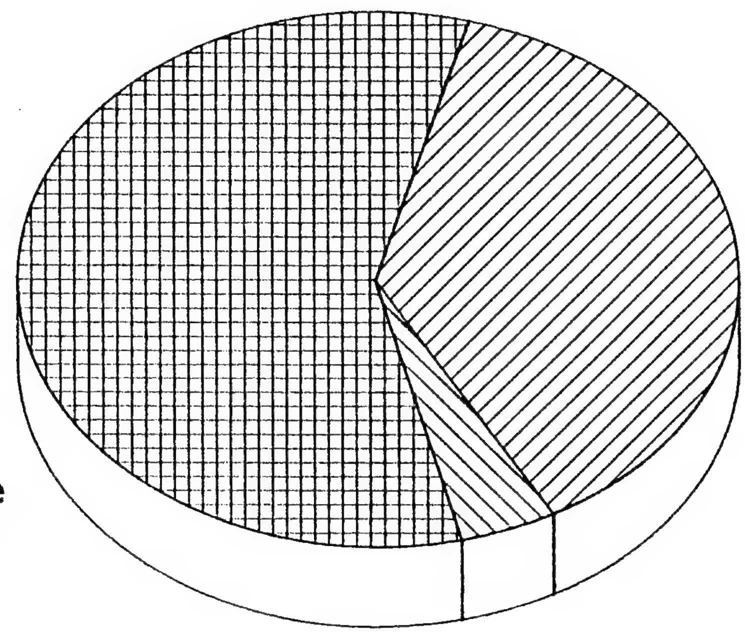


532 Output TWTs Screened

Figure 1 (b)

AN/ALQ-131 DRIVER TWTs

Program Summary: Total TWTs Screened
(Serviceable vs Unserviceable)



514 Driver TWTs Screened

Figure 1 (c)

1.0 INTRODUCTION

1.1 Background

Initial indications of a potential shelf storage problem with Traveling Wave Tubes (TWTs) arose in late 1986 when the USAF provided 127 AN/ALQ-135 Band I TWTs to Northrop as Government-Furnished Material on a system acquisition contract. These TWTs had been delivered to the government between 1982 and 1984 and had been in storage as serviceable depot stock. Northrop screened these tubes and rejected 44 for not meeting performance specifications. Subsequently Northrop published a White Paper, dated 3 August 1987, describing their investigation and recommendations on tube performance after extended storage. Northrop recommended further study of tube shelf life, continued burn-in of new tubes, and conditioning of tubes in storage every twelve months.

As a result of the Northrop findings and concern for the integrity of significant stock quantities of TWTs purchased and delivered in the mid- 1980's, WR-ALC begin initiating a series of actions to further define the shelf-life question for microwave tubes. On 15 March 1988, a meeting was held at Warner Robins ALC with personnel from Rome Air Development Center and the Air Force Acquisition Logistics Division to examine the issues. During the WR-ALC meetings, 21 AN/ALQ-94 TWTs were drawn from depot serviceable stock and tested in the WR-ALC Avionics Maintenance shops. Seventeen (17) of these tubes failed screening. They had been manufactured and delivered to the government in 1982 and had been in depot warehouses until they were tested nearly six years later. These findings further reinforced the developing shelf life concern.

The following week, on 23 March 1988, WR-ALC awarded a contract to Southwest Research Institute to define, analyze, and develop solutions for shelf-life problems associated with microwave tubes which have been in storage prior to use. This effort had been in the procurement cycle for some time, and its issue was simply coincidental to the events of the previous week. In this general time period work was also initiated on a statement of work leading to the study which is the subject of this report. The Southwest Institute contract resulted in the Georgia Tech Research Institute (GTRI) TWT, BWO, and CRT Shelf Life Study through a subcontract. This 17-month effort was completed in July 1989 and the final report issued in September 1989. GTRI was able to obtain only 84 tubes, mostly BWOs (64), for testing and found an overall 21% failure rate off-the-shelf. In addition, GTRI reported data from Northrop on 107 AN/ALQ-161 Band 8 TWTs tested in preparation for production system installation. Eleven of these 107 tubes were reported as failures for a rate of 10.3%. The most interesting aspect of the Northrop data was related to tube age in months at the time of testing and failure detection.

Seven of the eleven detected failures occured in twenty-five tubes which were two months at the time of testing, whereas only one failure occured in fifty-eight tubes which were one month old when tested. GTRI concluded: (1) that shelf failures occur early, primarily before the third month, (2) there seems to be a delay of one month before infant mortality sets in, peaking at 24.6% in the second month, and (3) that after the initial surge in infant mortality in month 2, the rate appears to drop by more that a factor of 3 to 7.9%. Georgia Tech recommended that tubes be operated after nearly 12 months of storage, as did Northrop in 1987. In addition, they recommended changes in storage and issue, handling, and procurement practices and the use of getters.

As the GTRI study was coming to an end and the inital findings were becoming known to WR-ALC program managers, the Westinghouse serviceable screening task contract was awarded in July 1989. This report details the comprehensive examination and empirical documentation of the serviceablility of 1046 AN/ALQ-131 Traveling Wave Tubes held in WR-ALC depot stock.

1.2 Task Facilities

All of the TWTs were tested at the Westinghouse Regional Service Center, 1000 Park Drive, Warner Robins, GA. The Westinghouse RSC is a 12,500 sq. ft. facility that contains electronics labs, a computer lab, secure video teleconferencing center, classroom, conference rooms, office space, loading dock, and a combination receiving/packing and shipping room. The facility is staffed by Westinghouse AN/ALQ-131 field engineers, software engineers, a Quality Assurance (Q.A.) inspector, field technicians and logisticians. The Quality system is in compliance with MIL-I-45208.

Figure 1.2 (a) shows the layout of the electronics lab where the TWT testing took place. Table 1.2 lists the test equipment used in testing the tubes.

Engineering Lab #2
Room #135

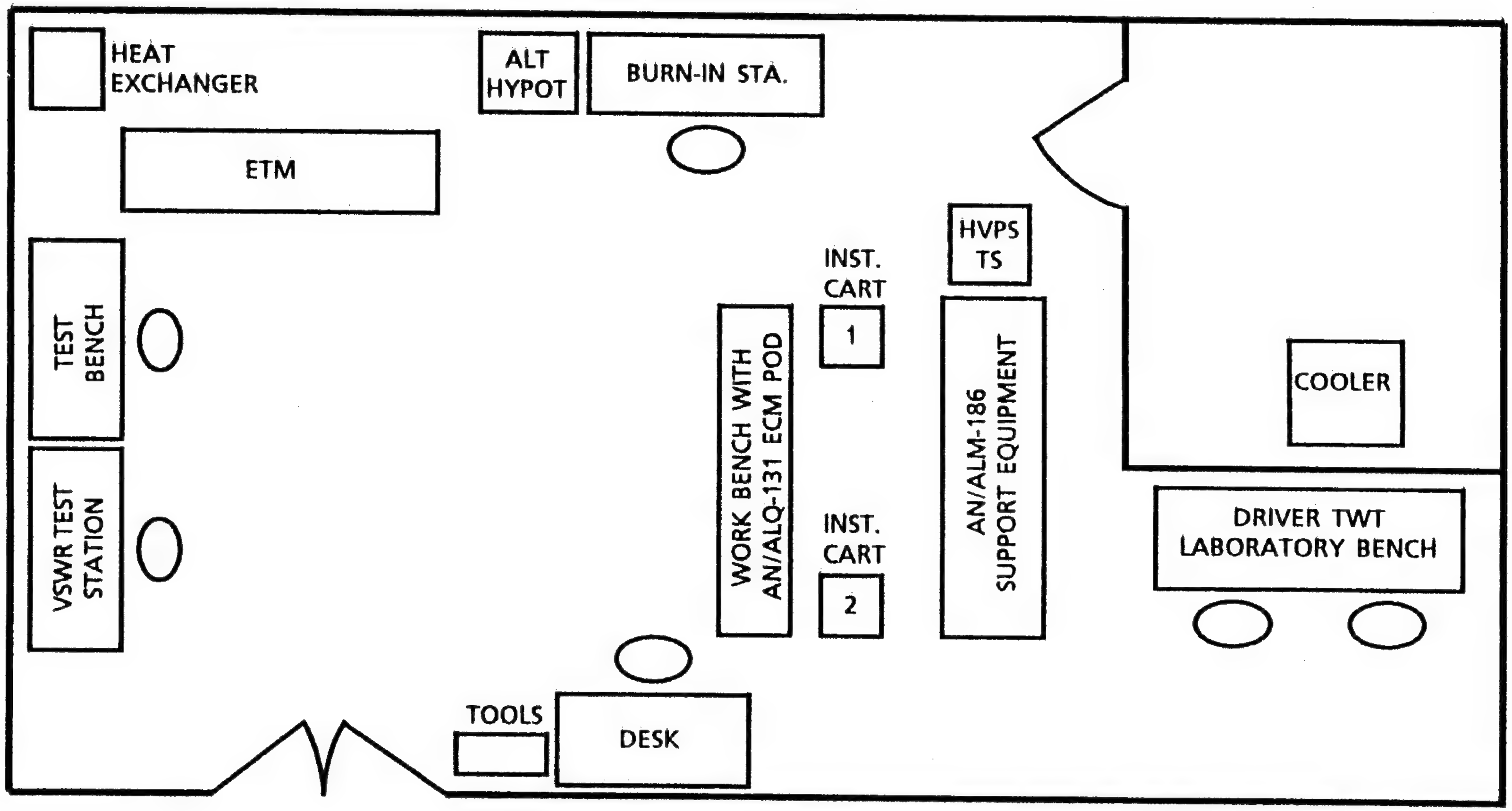


Figure 1.2 (a)

TABLE 1.2

TWT TESTING EQUIPMENT

Government-Furnished Equipment

1 set of ALM-186 Test Equipment for support of AN/ALQ-131 Block I

1 AN/ALQ-131 Block I system S/N 0034

1 AN/ALQ-131 Block II system S/N 0564

Contractor-Furnished Equipment

1 set of ALM-256 Intermediate Level Support Equipment (ILSE) for the AN/ALQ-131 Block II

1 ETM Universal TWT Test Set model 1513P2C.4

1 BEMCO altitude hypot chamber

2.0 EQUIPMENT AND TEST PROCEDURES

2.1 Output TWTs

2.1.1 Description of ETM Universal TWT Test Set

The Output Traveling Wave Tubes were tested utilizing the ETM. The ETM consists of a High Voltage Power Supply (HVPS) and associated RF test equipment [See Table 2.1.1 (a)]. The HVPS has the capability of testing a variety of helix or CW coupled-cavity TWTs. It contains a dual cathode, filament, modulator, and three variable collector supplies. The ETM is capable of testing TWTs with duty cycles of .01% (i.e., pulse) to continuous wave (CW). The power supply can be used to test the TWTs employed on various airborne EW platforms including the AN/ALQ-94, AN/ALQ-99, AN/ALQ-119, AN/ALQ-101, QRC 80-01, AN/ALQ-126, AN/ALQ-131, AN/ALQ-135, AN/ALQ-161, AN/ALQ-165, and AN/ALQ-172.

2.1.2 Test Procedures

A comprehensive test procedure was developed that would allow for uniform testing of all output TWTs. This test procedure is outlined in Figures 2.1.2 (a & b). Figure 2.1.2 (a) covers the receipt of the TWT, test sequence, and shipment of the TWT. Figure 2.1.2 (b) covers the functions of the Failure Review Board.

Upon receipt the following information was documented and entered into the data base system:

- Part Number
- Stock Number
- Serial Number
- Vendor
- Date packed at manufacturer
- Date received at WR-RSC
- Serviceable tag present
- Physical examination of inner and outer containers
- Physical examination of inner bag vacuum seal

After completion of the initial documentation, a physical inspection was performed on the following:

- Mechanical damage on baseplate, SMA input connectors, and phase shifter.
- Visual inspection of output RF connector for arc marks across the interface, contamination, and pin damage.
- Visual inspection of output RF connector and waveguide for evidence of arcing, burning, overheating, and waveguide damage.
- Visual inspection of collector area for evidence of overheating.

Output TWT Commercial Test Equipment			
Item	Manufacturer	Part Number	Description
1	Sys Donner	100C	Pulse Generator
2	ETM	1513P2C.4	High Voltage Power Supply
3	H.P.	1725A	Oscilloscope
4	H.P.	1742A	Oscilloscope
5	Omega	199	Gauge, Temp
6	Narda	3305-4	Divider, Power
7	TMEC	375-20	Voltmeter, Digital
8	H.P.	428B	Ammeter, D.C.
9	H.P.	432A	Power Meter
10	H.P.	435A	Power Meter
11	H.P.	432B	Power Meter
12	Narda	4456-2	Divider, Power
13	H.P.	5314A	Frequency Counter
14	EIP	575	Frequency Counter
15	H.P.	6200B	Power Supply, Low DC
16	H.P.	6209B	Power Supply, Low DC
17	H.P.	6264B	Power Supply, Low DC
18	H.P.	6284A	Power Supply, Low DC
19	Triplett	630-PLK	Multimeter
20	H.P.	7035B	Recorder, X-Y
21	H.P.	7563A	Amp/Voltmeter, Log.
22	Hipotronic	830-5	High Voltage Power Supply
23	H.P.	8349B	Amp, Microwave
24	H.P.	8350A	Sweep Oscillator, Main Frame
25	H.P.	8350B	Sweep Oscillator
26	H.P.	83590A	Sweep Oscillator, Plug-In
27	H.P.	8478B	Thermistor Mount
28	H.P.	8481A	Power Sensor
29	H.P.	85027A	Directional Bridge
30	Wavetek	8502A	Peak Power Meter

Table 2.1.1 (a)

Output TWT Commercial Test Equipment			
Item	Manufacturer	Part Number	Description
31	H.P.	8569B	Spectrum Analyzer
32	Narda	8611	Meter, Radiation
33	H.P.	8756A	Network Analyzer
34	Bemco	A8C	Chamber, Environment-Temp
35	TMEC	AFA-388	Filament Age Rack
36	Avantek	APT18659	Amp, Microwave, Solid State
37	Raytheon	CJB2000MHR-1	Load, Water, W/G
38	Raytheon	CJK2000	Load, Water, Coax
39	Oneac	CL1101	Insolation Transformer
40	Omega	CS4002VC	Temp, Controller
41	TEK	P6015	High Voltage Probe
42	Microwave Eng	R160A-5N	Load
43	Raytheon	STC1000A	Power Meter, Calorimetric
44	Raytheon	WRD475M	Load, Water, W/G
45	Raytheon	WRD475M-HP	Load, Water, W/G
46	Raytheon	WRD750B-HP1	Load, Water, W/G

Table 2.1.1 (a) continued

If any of the above inspections failed, the TWT was referred to the Failure Review Board for final disposition. If there was not any observable damage, the heater, cathode, and thermostat were checked for continuity using a volt-ohm meter, and the preliminary tests were completed. The TWT was then placed into an altitude chamber to perform an ambient hypot to check for any shorts at sea level. If the ambient hypot passed, then an altitude hypot was performed to check for shorts at 60,000 feet. If either of these tests failed, the TWT was referred to the Failure Review Board for final disposition. If both hypot tests passed, the TWT was put on the burn-in bench and a twenty-minute filament burn-in was performed. At the completion of the filament burn-in the TWT was installed on the ETM test stand and performance test were performed. If the TWT failed the filament burn-in or performance test, it was referred to the Failure Review Board for final disposition. If not, the TWT was categorized as serviceable. Final documentation was completed and entered into the data base system. The TWT was then stored until it could be shipped back to WR-ALC.

The Failure Review Board was tasked to analyze each failed TWT on a case-by-case basis. After analyzing all of the test data associated with each TWT, the Failure Review Board would make a decision on the disposition of that tube. If it was determined that the TWT would meet the AN/ALQ-131 system specifications, the tube was categorized as serviceable. If the TWT would not meet the system specifications, it was categorized as unserviceable. The Failure Review Board could also request that a TWT be retested on the ETM if a decision could not be made after analyzing all of the test data. After the TWT was retested, the Failure Review Board would re-analyze the test data in order to make a final decision. If the Failure Review Board could not be certain if a TWT would meet system specifications, they would request that the TWT be system tested. At the completion of the system test, the Failure Review Board would re-analyze the data in order to make a final decision.

OUTPUT TWT TEST PROCEDURES

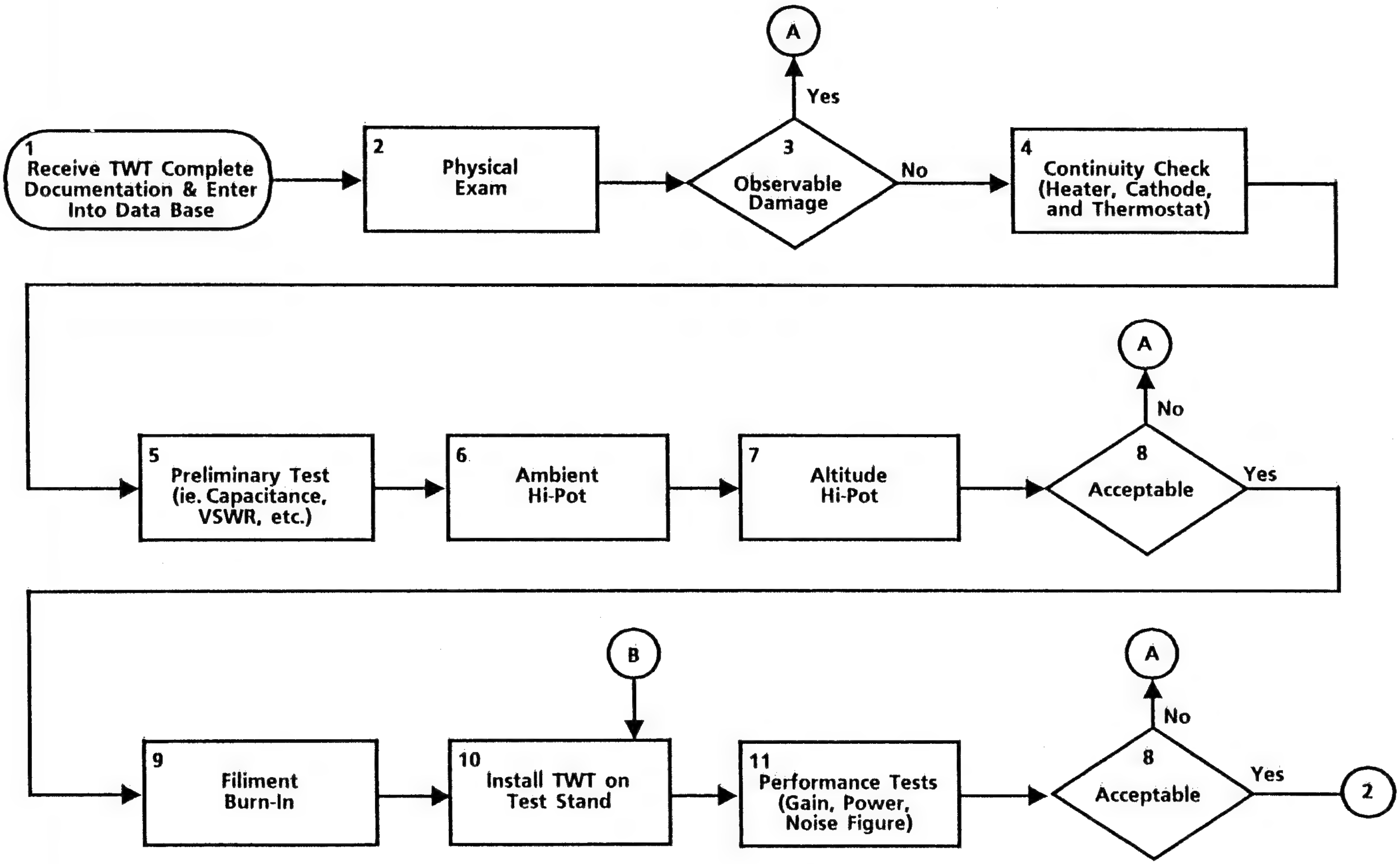


Figure 2.1.2 (a)

OUTPUT TWT TEST PROCEDURES

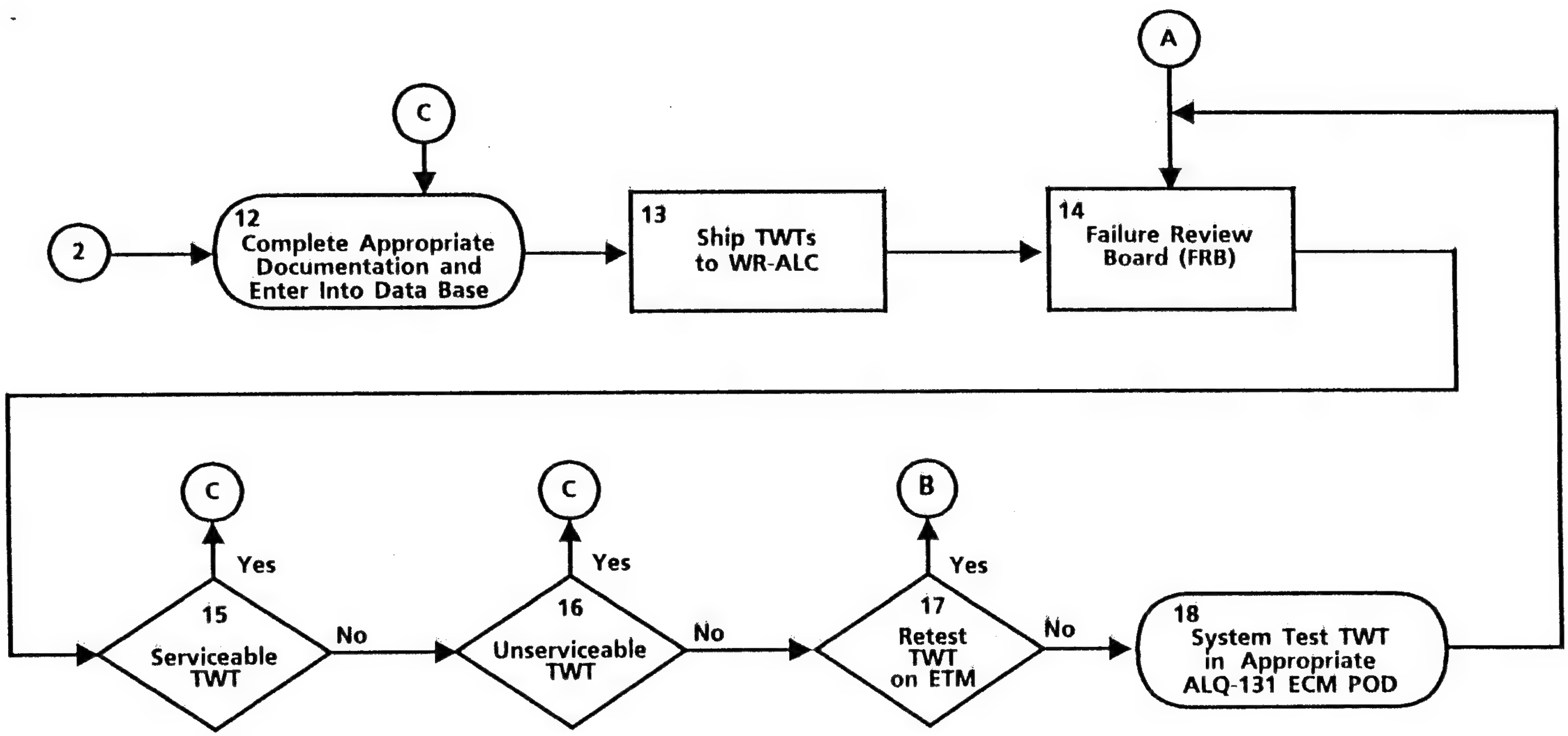


Figure 2.1.2 (b)

2.1.3 System Test Procedures

At the beginning of the screening effort, it was determined that the AN/ALQ-131 system test would be utilized to validate the test results from the ETM. A random sample from each type of TWT tested was connected to the AN/ALQ-131 ECM pod and system tests performed. This sample consisted of TWTs that passed as well as TWTs that failed the ETM tests. The following tests were performed on each selected TWT:

- All band high voltage load (ABHVLD) was performed if the high voltage power supply was not set up to the operating voltages of the TWT.
- All band inline test (ABINLN) was performed on each TWT to make sure that the TWT was operational.
- All band TWT alignment (ABTWTA) was performed to check the phase shifter adjustment.
- Output group gain (ABOTGA) was performed to check the gain of the output TWT.
- Repeater power (ABPOWM) or 05GANO) was performed to check the power output of the TWT.
- Over all gain (34GOAA or 05GOAA) was performed only if the TWT had failed the ETM test for fine grain (ripple).
- Thermal noise (34THRM) was performed on bands 3 and 4 to check for the thermal noise output from each TWT.

The Failure Review Board could also request that a TWT undergo the system tests mentioned above. The added information would be used to determine the final disposition of certain tubes. The system test specifications were the criteria used to determine if the TWT was returned to WR-ALC as serviceable or unserviceable.

2.2 Driver TWTs

2.2.1 Description of Laboratory Test Equipment

The test equipment utilized to screen the driver TWTs consisted entirely of commercial test equipment [Table 2.2.1 (a)]. This equipment was used to operate a driver TWT laboratory test bench located inside Engineering Lab 2. The test bench was equipped with a 400 hertz power distribution box, locally manufactured, which could be used to burn-in and test a maximum of four TWTs at the same time. Each driver TWT was connected to the test bench and tested according to the procedures outlined in the following paragraph.

2.2.2 Test Procedures

A comprehensive test procedure was developed that would allow for uniform testing of all driver TWTs. This test procedure is outlined in Figures 2.2.2 (a & b). Figure 2.2.2 (a) covers the receipt of the TWT, test sequence, and shipment of the TWT.

Driver TWT Commercial Test Equipment			
Item	Manufacturer	Part Number	Description
1	H.P.	432A	Power Meter
2	H.P.	435B	Power Meter
3	H.P.	7035B	Recorder, X-Y
4	H.P.	7563A	Amp/Voltmeter, Log.
5	H.P.	8350A	Sweep Oscillator, Main Frame
6	H.P.	83590A	Sweep Oscillator, Plug-In
7	H.P.	8478B	Thermistor Mount
8	H.P.	8481A	Power Sensor

Table 2.2.1 (a)

Figure 2.2.2 (b) covers the functions of the Failure review Board. Upon receipt the following information was documented and entered into the data base system:

- Part Number
- Stock Number
- Serial Number
- Vendor
- Date packed at manufacturer
- Date received at WR-RSC
- Serviceable tag present
- Physical examination of inner and outer containers
- Physical examination of inner bag vacuum seal

After completion of the initial documentation, a physical inspection was performed on the following:

- Mechanical damage on baseplate and SMA input connectors
- Visual inspection the RF connectors for arc marks across the insulator, contamination, and pin damage.

If any of the above inspections failed, the TWT was referred to the Failure Review Board for final disposition. If there was not any observable damage, the TWT was burned in for an appropriate amount of time. When the TWT was initially tested it first had a three-minute burn-in. Then the small signal gain test was performed a plot of the test results taken. The TWT was then burned-in for an additional thirty (30) minutes. At the completion of the burn-in, the small signal gain test was performed again and a plot of the test results was taken. The noise power test was the next test performed. A plot of TWT output power was taken. If the TWT failed any of the above tests, it was referred to the Failure Review Board for final disposition. The final test was to calculate the noise figure for the TWT under test. If it failed, the TWT was referred to the Failure Board for final disposition. Otherwise, it was categorized as serviced, and final documentation was completed. The TWT was then stored until it could be shipped back to WR-ALC.

The Failure Review Board was tasked to analyze each failed TWT on a case-by-case basis. After analyzing all of the test data associated with each TWT, the Failure Review Board would make a decision as to the disposition of that tube. If it was determined that the TWT would meet the AN/ALQ-131 system specifications, the tube was categorized as serviceable.

If the TWT would not meet the system specifications, it was categorized as unserviceable. The Failure Review Board could also request that a TWT be retested on the bench, if a decision could not be made after analyzing all of the test data. After the TWT was retested, the Failure Review Board would re-analyze the test data to make a final decision.

DRIVER TWT TEST PROCEDURES

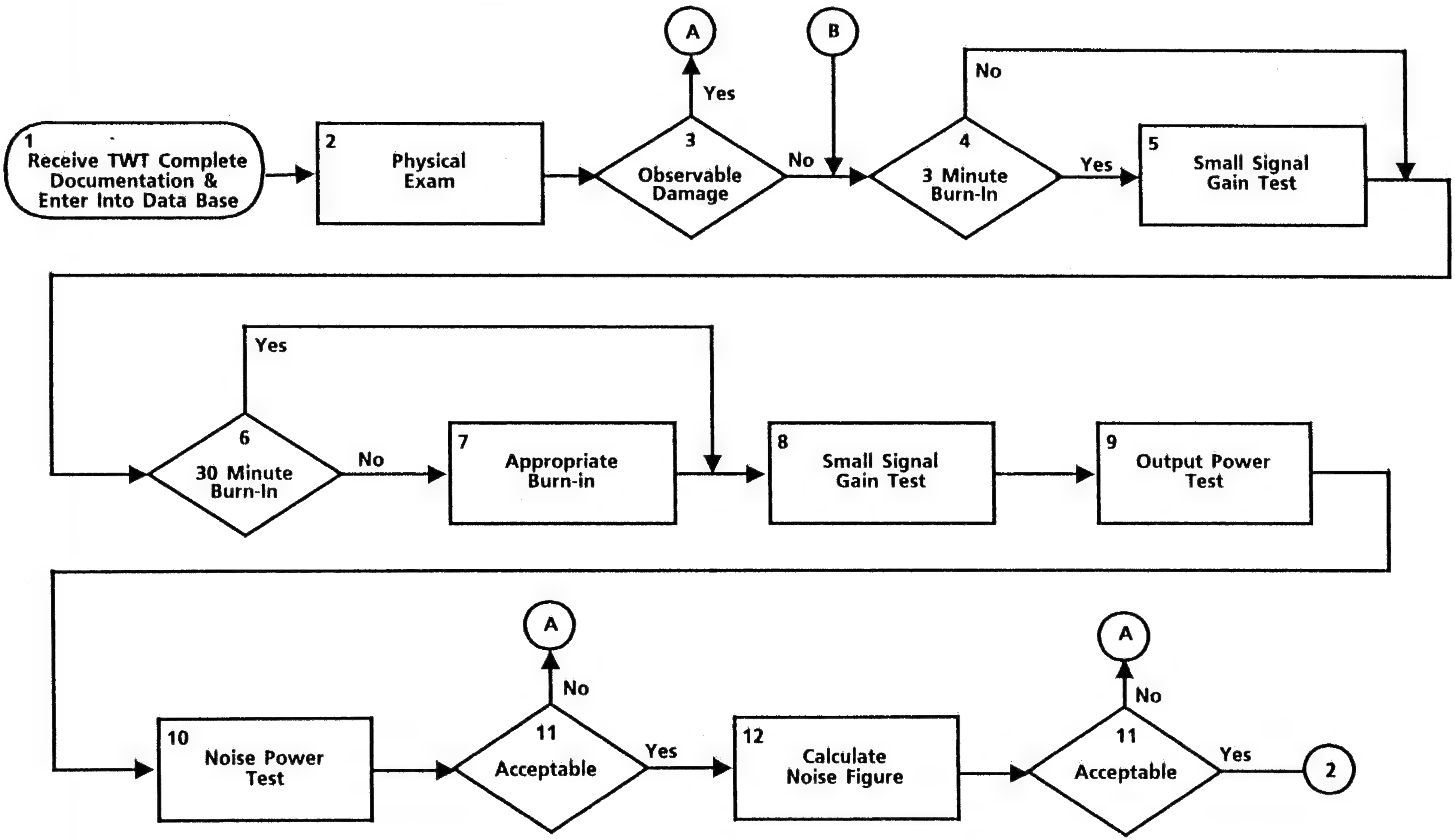


Figure 2.2.2 (a)

DRIVER TWT TEST PROCEDURES

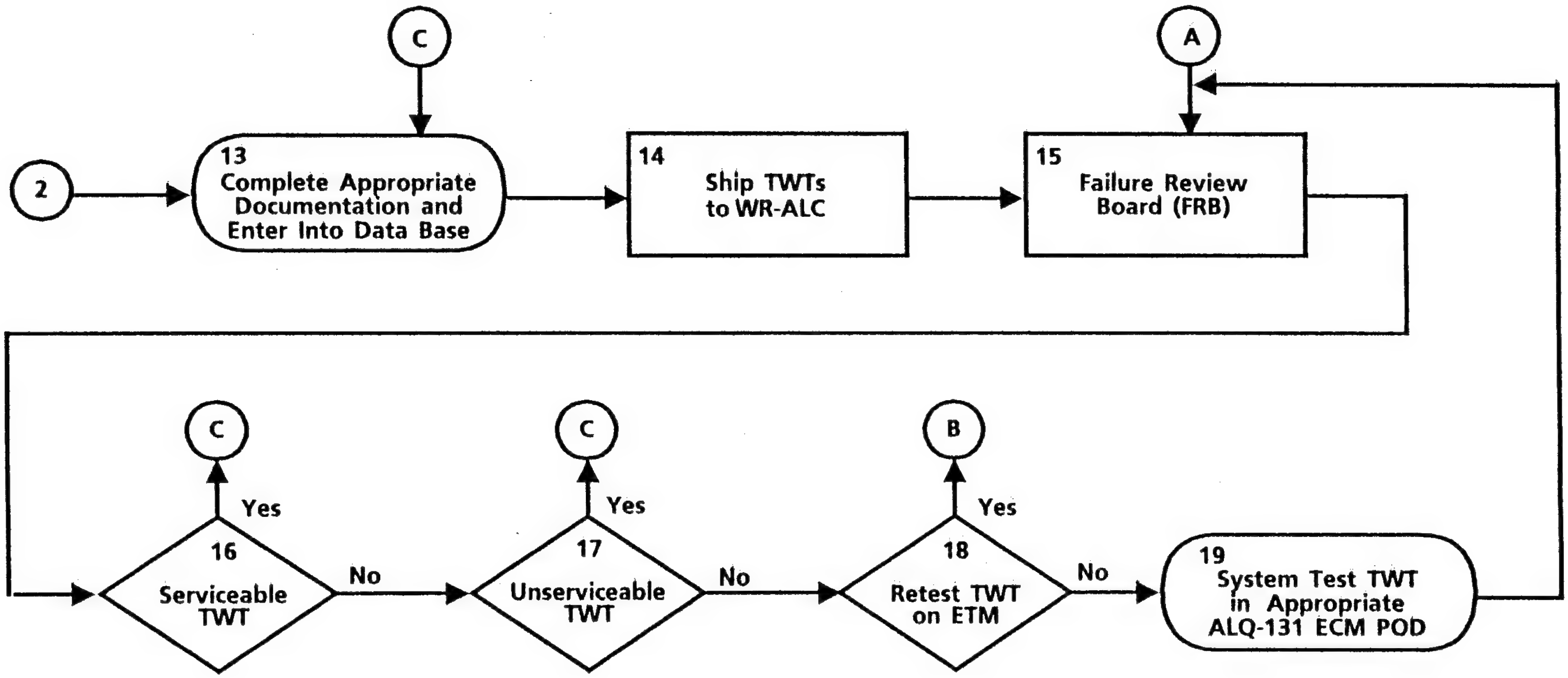


Figure 2.2.2 (b)

3.0 FAILURE REVIEW BOARD (FRB)

3.1 FRB Membership

A Failure Review Board, consisting of a system engineering manager, a transmitter design engineer, a field engineer, and a TWT design engineer met periodically to review TWT test data. The expertise and experience of the members provided a technical basis for determining how interrelated tube parameters could impact system performances and how best to dispose of tubes with questionable test data.

3.2 FRB Pass/Fail Criteria

Tubes that passed the ETM testing were returned to the government as serviceable. Tubes that failed catastrophically were returned as unserviceable, and tubes that failed marginally were reviewed in detail to see if they could be declared serviceable. Gain, power, ripple, helix current, and frequency were considered and compared to the tube specification and system performance requirements. If a failed parameter had sufficient margin, the tube was declared serviceable. If a failed parameter prevented the system from meeting its requirements, the tube was declared unserviceable. In some cases the FRB needed additional data and measurements would be made using either the system or ETM to obtain the data.

Figures 3.2 (a), 3.2 (b), and 3.2 (c) show samples of the different power output measurements observed by the FRB. Figure 3.2 (a) shows a measured output power that exceeds the system and TWT specifications. TWTs that met all of the TWT specifications were returned to the USAF as serviceable. Figure 3.2 (b) shows a measured output power that fails the TWT specification, but passed the system specification. If all other parameters passed, the FRB would return the tubes to the USAF as serviceable.

Figure 3.2 (c) shows a measured output power that fails both the TWT and system specifications. This tube would be returned to the USAF as unserviceable.

Figure 3.2 (d) shows a gain plot where fine-grain (ripple) is measured. If the fine-grain measurement failed the TWT specifications, but passed the system specification, the tube was returned to the USAF as serviceable. If the fine-grain measurement failed both the TWT and system specification, the FRB would return the tube as unserviceable.

FRB PASS/FAIL CRITERIA

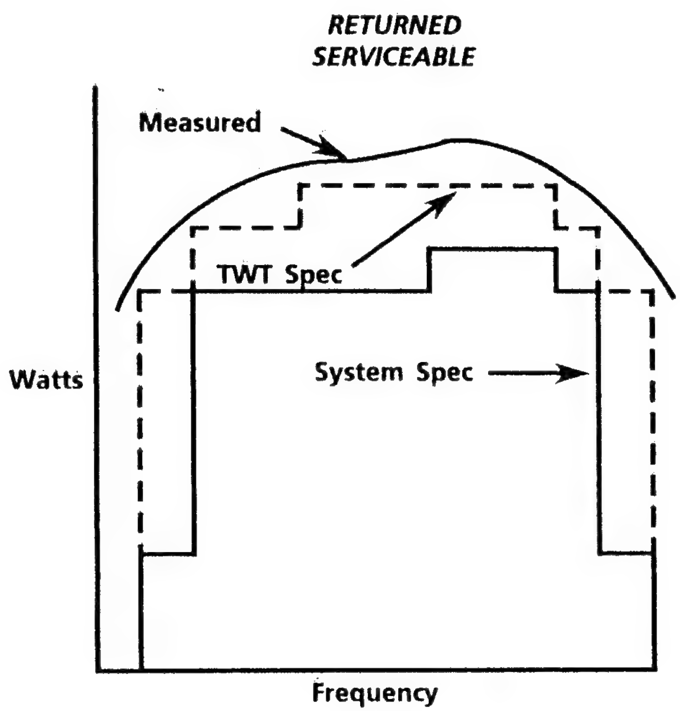


Figure 3.2 (a)

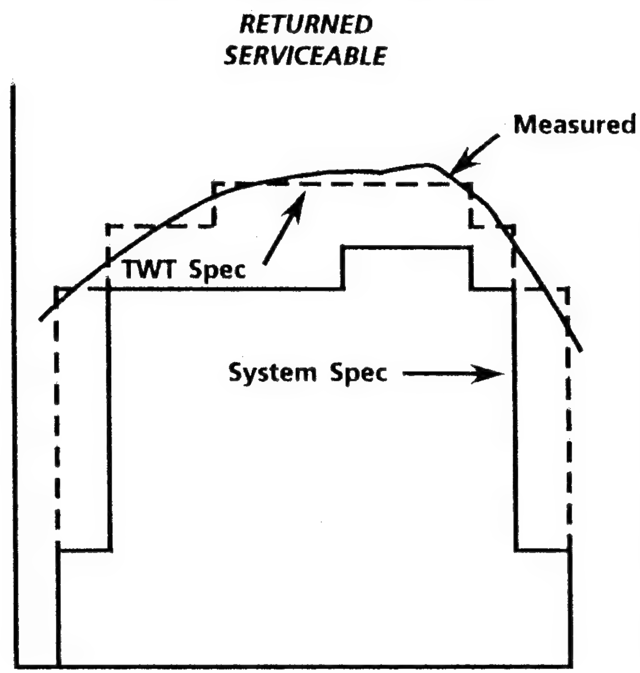


Figure 3.2 (b)

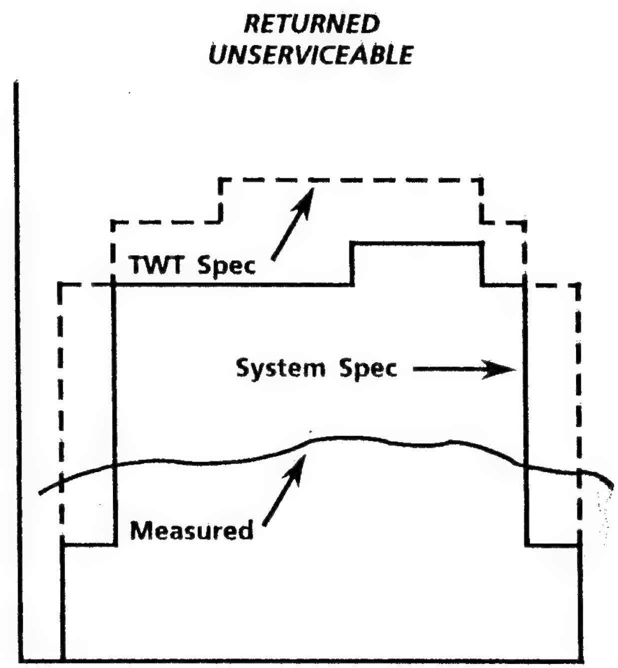


Figure 3.2 (c)

Power Output

FRB PASS/FAIL CRITERIA

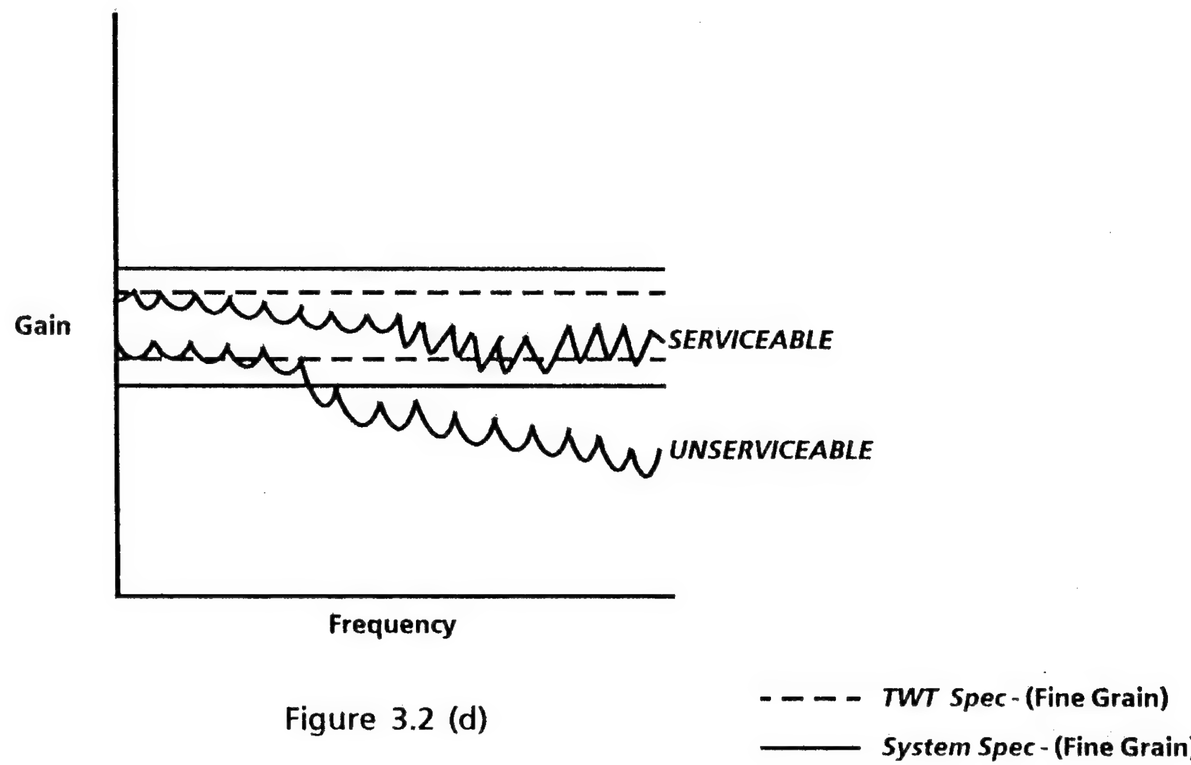


Figure 3.2 (d)

Gain

4.0 TEST SUMMARY - OUTPUT TWTS

4.1 Output TWTs Description

The three types (Bands 3, 4, and 5) of AN/ALQ-131 Output Traveling Wave Tubes are wide band, high power helix type PPM focused microwave devices. All three have provisions for controlling the beam. The helix RF circuit is used to produce wide bandwidths exceeding an octave. The TWTs have equalizers which reduces the gain curve from 15 to 5dB. In addition, the TWTs have phase shifters so that the second harmonic from the RF driver can be adjusted to enhance the RF power from the output TWT over the lower part of the frequency band. All TWTs are conduction cooled.

The three basic elements of a TWT are the gun, RF circuit and focusing system and the collector. The gun creates the electron beam, the focusing system guides the electron beam through the slow wave RF structure (helix), and the collector collects the unused electron beam.

The Band 3 CW TWT is used on the Block I and II and operates at a cathode voltage of -6Kv. A shadow grid is used for beam control. The TWT has two stages of collector depression which improves the overall efficiency.

The Band 5 pulse TWT is used only on Block I and operates at -12Kv and uses an intercepting grid for beam control. This TWT has only one stage of collector depression.

Two different Band 4 CW TWTs are used on the Block I and II. Both TWTs operate at a cathode voltage of -9Kv and have similar RF parameters. A focus electrode is used for beam control. The only difference is that the Block II TWT has three stages of collector depression, while the Block I tube has only one stage. The three-stage collector increases the efficiency of the Block II tube from 17% to 25%.

4.2 Test Results

A total of 532 output TWTs were screened at the Warner Robins Regional Service Center from January 1990 through December 1990. The TWTs were manufactured by Litton, Varian, and Teledyne MEC (TMEC), and consisted of bands 3, 4, and 5 as well as new and used tubes [Table 4.2 (a)]. All of the output TWTs were screened in accordance to the test procedures outlined in paragraph 2.1.2. A summary of the ETM screening results is depicted in Table 4.2 (b). The TWTs that failed the ETM screening were referred to the Failure Review Board (FRB). The FRB analyzed the data from each TWT that failed the ETM screening on a case-by-case basis [Table 4.2 (c)]. If it was determined that the TWT would pass the AN/ALQ-131 system test, then it was categorized as serviceable [Table 4.2 (d)].

Vendor	Part Number	Stock Number	Band	New/Used
Litton	583R679H01	5960-01-040-4440EW	3	Used
Varian	583R679H03	5960-01-069-8028EW	3	Used
Varian	583R821H02	5960-01-040-4442EW	4	New
Varian	583R822H02	5960-01-040-4441EW	5	New
TMEC	583R679H04	5960-01-299-5832EW	3	New
TMEC	585R182H02	5960-01-116-8859EW	4	New

Table 4.2 (a) Types of Output TWTs Screened

Vendor	Band	Quantity Screened	Quantity Passed	Quantity Failed
Litton	3	26	1 (3.8%)	25 (96.2%)
Varian	3	118	36 (30.5%)	82 (69.5%)
Varian	4	274	222 (81.0%)	52 (19.0%)
Varian	5	70	56 (80.0%)	14 (20.0%)
TMEC	3	39	34 (87.2%)	5 (12.8%)
TMEC	4	5	4 (80.0%)	1 (20.0%)
Totals:		532	353 (66.4%)	179 (33.6%)

Table 4.2 (b) Output TWTs ETM Results

Vendor	Band	New/ Used	Quantity Reviewed	Quantity Passed	Quantity Failed
Litton	3	Used	25	3 (12.0%)	22 (88.0%)
Varian	3	Used	82	25 (30.5%)	57 (69.5%)
Varian	4	New	52	17 (32.7%)	35 (67.3%)
Varian	5	New	14	9 (64.3%)	5 (35.7%)
TMEC	3	New	5	1 (20%)	4 (80.0%)
TMEC	4	New	1	1 (100%)	0
Totals:			179	56 (31.3%)	123 (68.7%)

Table 4.2 (c) FRB Results for Output TWTs

Vendor	Band	New/ Used	Quantity Screened	Quantity Serviceable
Litton	3	Used	26	4 (15.4%)
Varian	3	Used	118	61 (51.7%)
Varian	4	New	274	239 (87.2%)
Varian	5	New	70	65 (92.9%)
TMEC	3	New	39	35 (89.7%)
TMEC	4	New	5	5 (100%)
Totals:			532	409 (76.9%)

Table 4.2 (d) Program Results for Output TWTs

4.2.1 Program Results

Of the 532 TWTs screened, 409 (77%) were serviceable and 123 (23%) were unserviceable [Figure 4.2.1 (a)]. Three hundred fifty-three (66%) of the 532 TWTs screened passed the initial ETM screening, and 179 (34%) were referred to the FRB for analysis. Fifty-six (31%) of the 179 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 4.2.1 (b)].

4.2.2 New Versus Used TWTs

The output TWTs were broken down into two categories, new and used. The new TWTs were tubes that were still in the original manufacturer's shipping containers. The used TWTs were tubes that had previously failed in the field and had been returned to the USAF supply system as serviceable. A total of 388 (73%) of the output TWTs were new and 144 (27%) were used [Figure 4.2.2 (a)].

Three hundred forty-four (89%) of the 388 new output TWTs were serviceable and 44 (11%) were unserviceable [Figure 4.2.2 (a)]. Three hundred sixteen (81%) of the 388 new TWTs passed the initial ETM screening, and 72 (19%) were referred to the FRB. Twenty-eight (39%) of the 72 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 4.2.2 (b)]. Sixty-five (45%) of the 144 used TWTs were serviceable and 79 (55%) were unserviceable [Figure 4.2.2 (a)]. Thirty-seven (26%) of the 107 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 4.2.2 (c)].

4.2.3 Bands

The output TWTs were further broken down into three (3) bands: 183 (34.4%) Band 3 TWTs, 279 (52.4%) Band 4 TWTs, and 70 (13.2%) Band 5 TWTs were screened on the ETM [Figure 4.2.3 (a)].

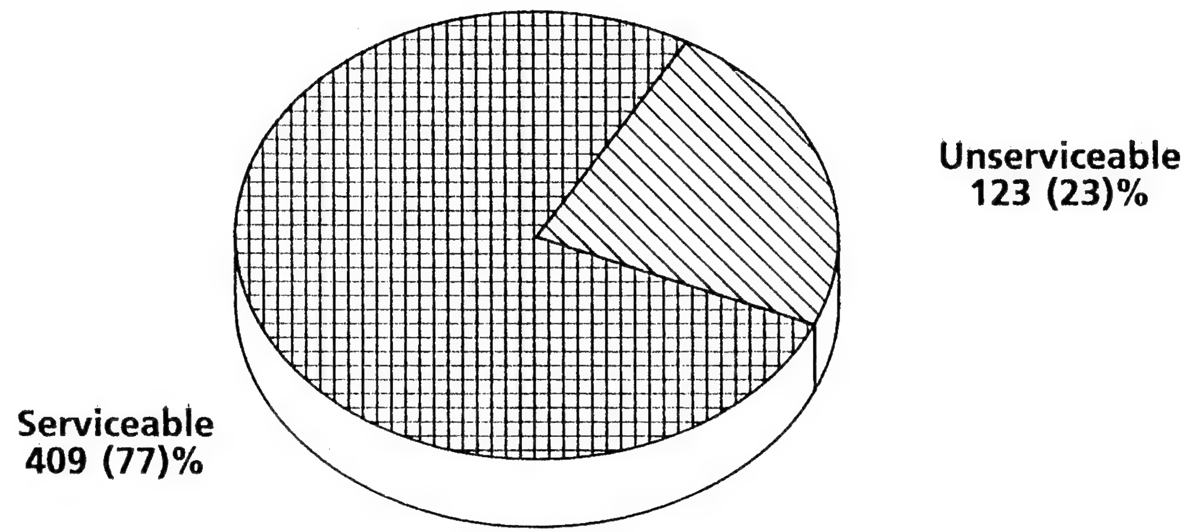
4.2.4 Band 3 TWTs

There were 183 Band 3 output TWTs screened. One hundred (55%) of the Band 3 TWT were serviceable, and 83 (45%) were unserviceable [Figure 4.2.4 (a)]. Seventy-one (39%) of the 183 TWTs passed the initial ETM screening, and 112 (61%) were referred to the FRB. Twenty-nine (26%) of the 112 TWTs analyzed by the FRB were passed and returned as serviceable [Figure 4.2.4 (b)]. The Band 3 output TWTs were further broken down into two categories, new and used. Of the 183 Band 3 TWTs, 39 (21%) were new, and 144 (79%) were used [Figure 4.2.4 (c)]. The new TWTs were manufactured by Teledyne MEC (TMEC), and the used TWTs were manufactured by Litton and Varian.

Thirty-five (90%) of the 39 new TMEC TWTs were serviceable, and 4 (10%) were unserviceable [Figure 4.2.4 (d)]. Thirty-four (87%) of the 39 TWTs passed the initial ETM screening, and 5 (13%) were referred to the FRB. One (20%) of the 5 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 4.2.4 (e)].

AN/ALQ-131 OUTPUT TWTs

Program Summary: Total TWTs Screened
(Serviceable vs Unserviceable)



532 Output TWTs Screened

Figure 4.2.1 (a)

AN/ALQ-131 OUTPUT TWTs

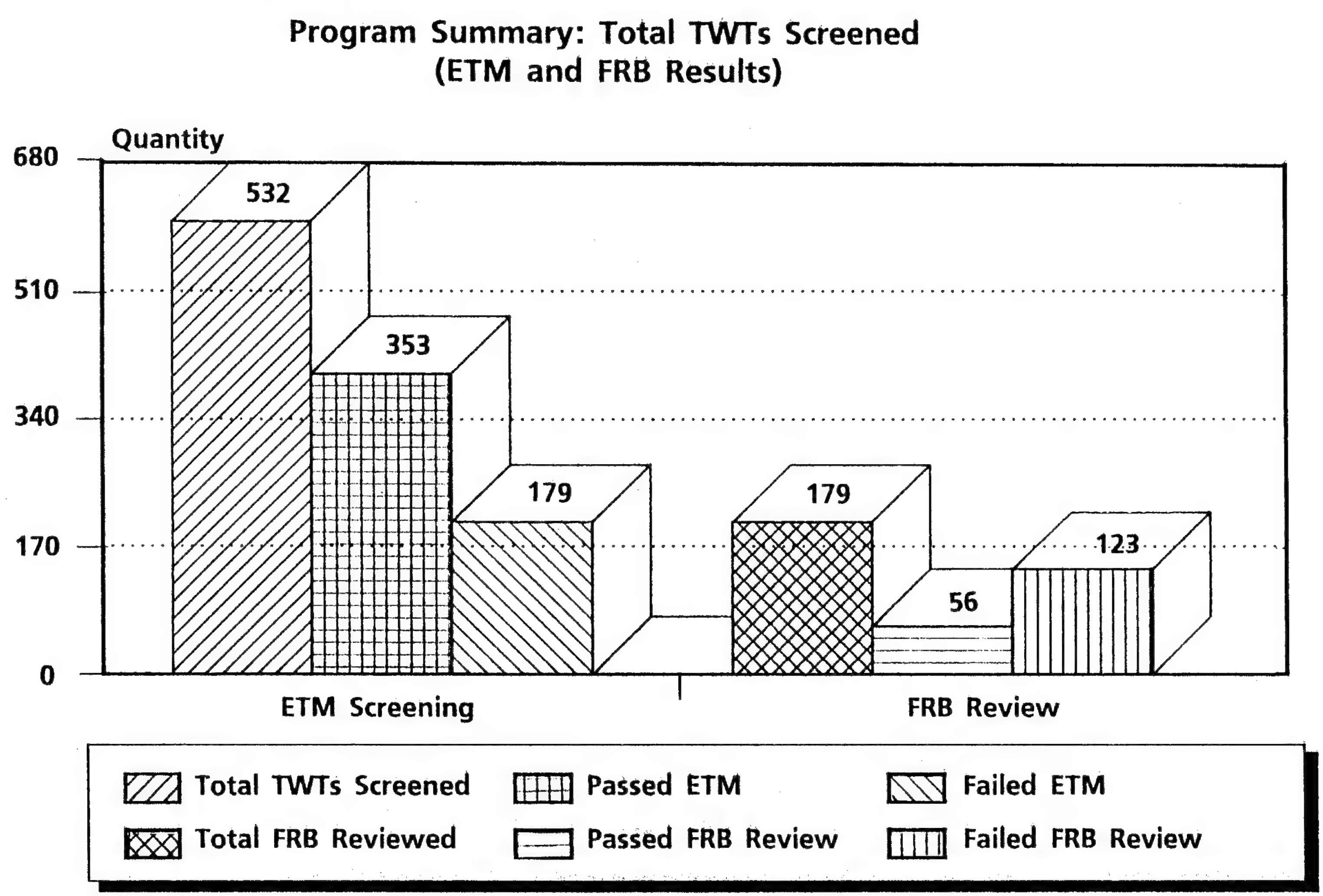
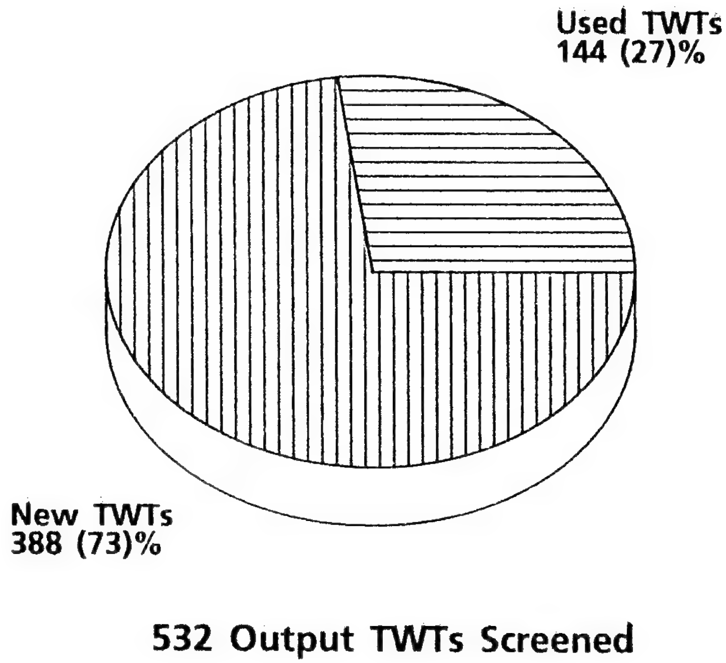
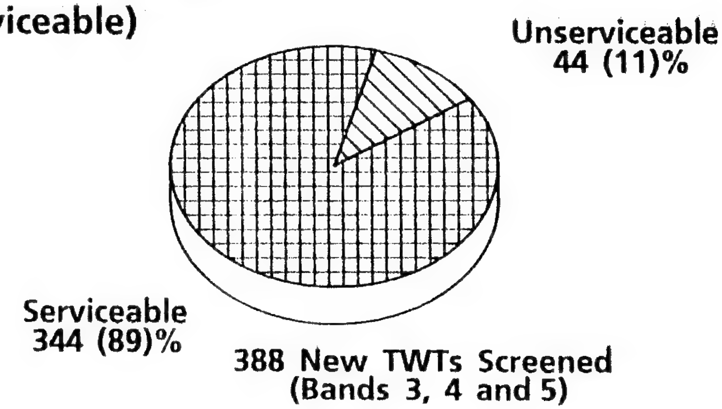


Figure 4.2.1 (b)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Total New Versus Used
(Serviceable Versus Unserviceable)





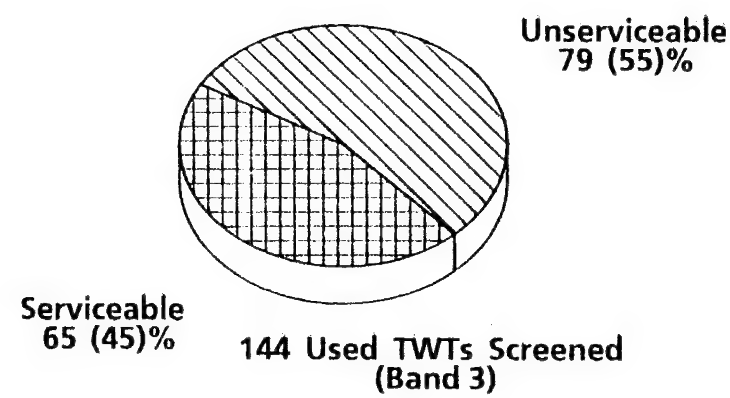


Figure 4.2.2 (a)

AN/ALQ-131 OUTPUT TWTs

Program Summary: New TWTs Screened
(ETM and FRB Results)

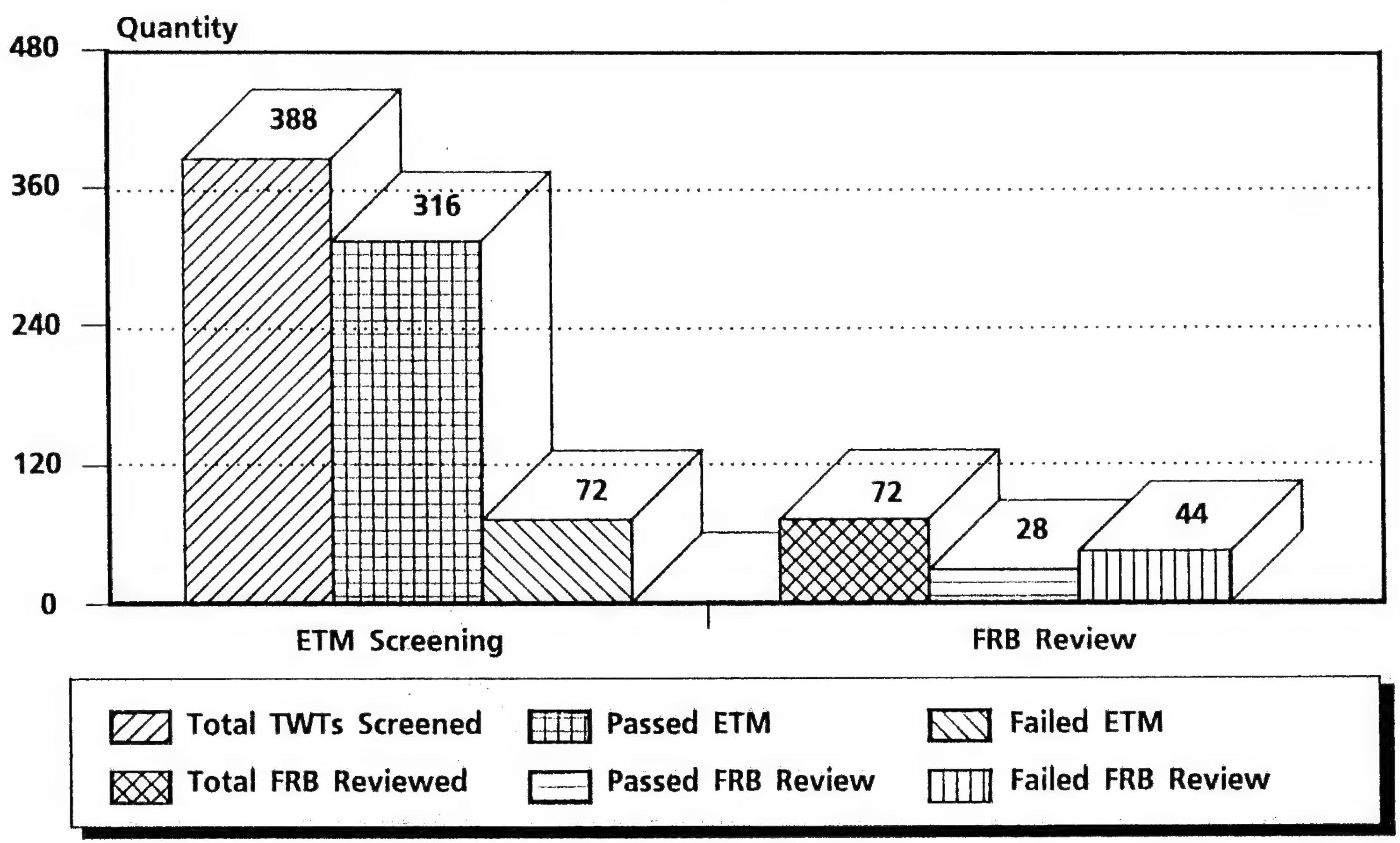


Figure 4.2.2 (b)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Used TWTs Screened
(ETM and FRB Results)

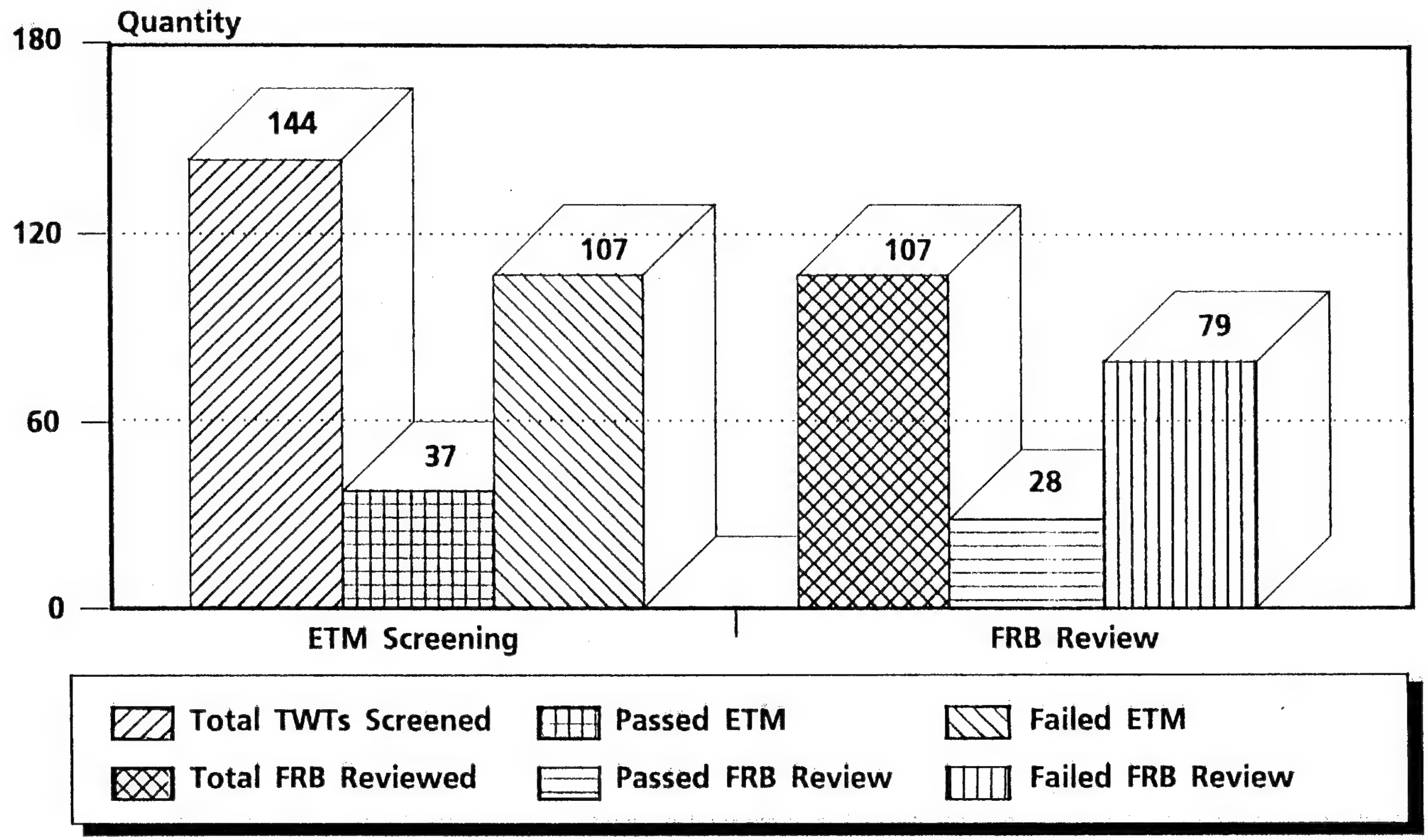
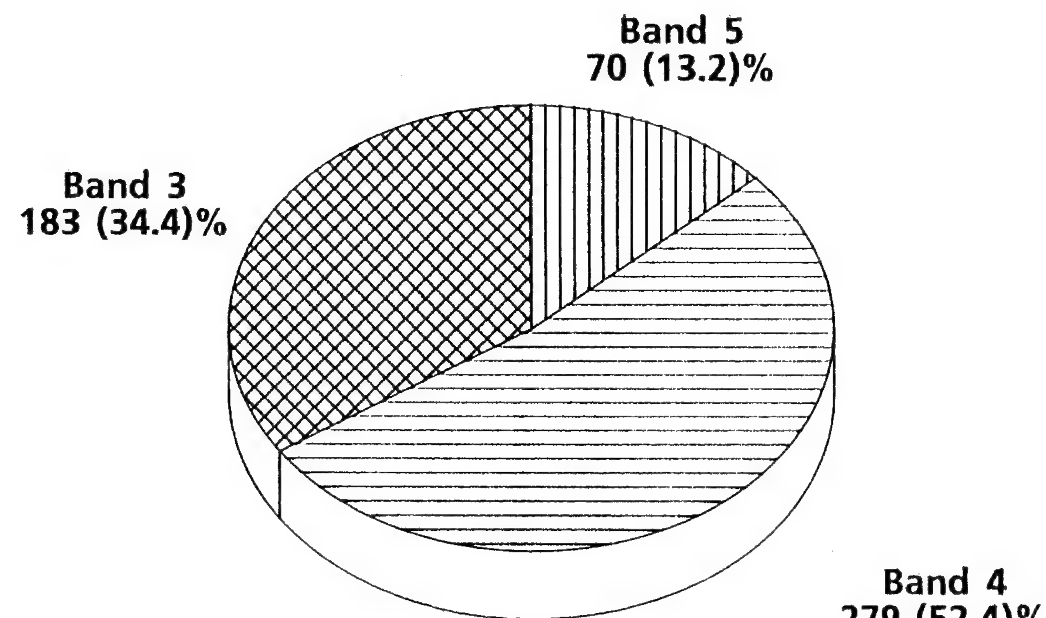


Figure 4.2.2 (c)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Total TWTs Screened
(Band 3, 4, and 5)

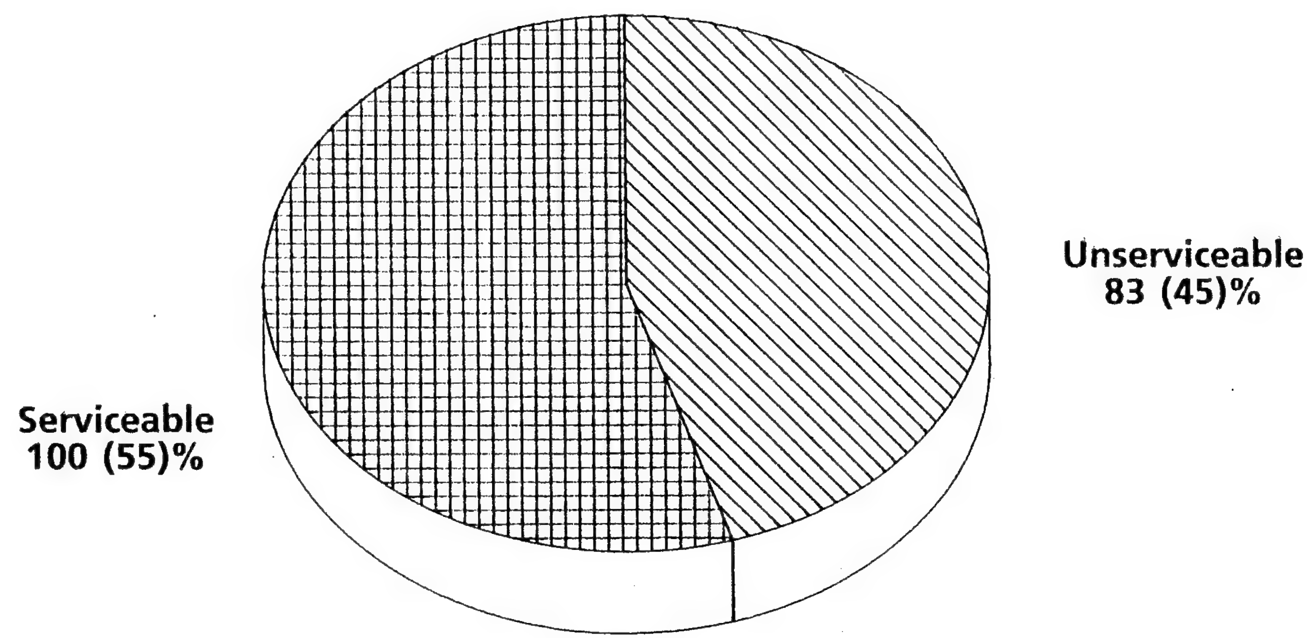


532 Output TWTs Screened

Figure 4.2.3 (a)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 3 TWTs Screened
(Serviceable vs Unserviceable)



183 Output TWTs Screened

Figure 4.2.4 (a)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 3 TWTs Screened
(ETM and FRB Results)

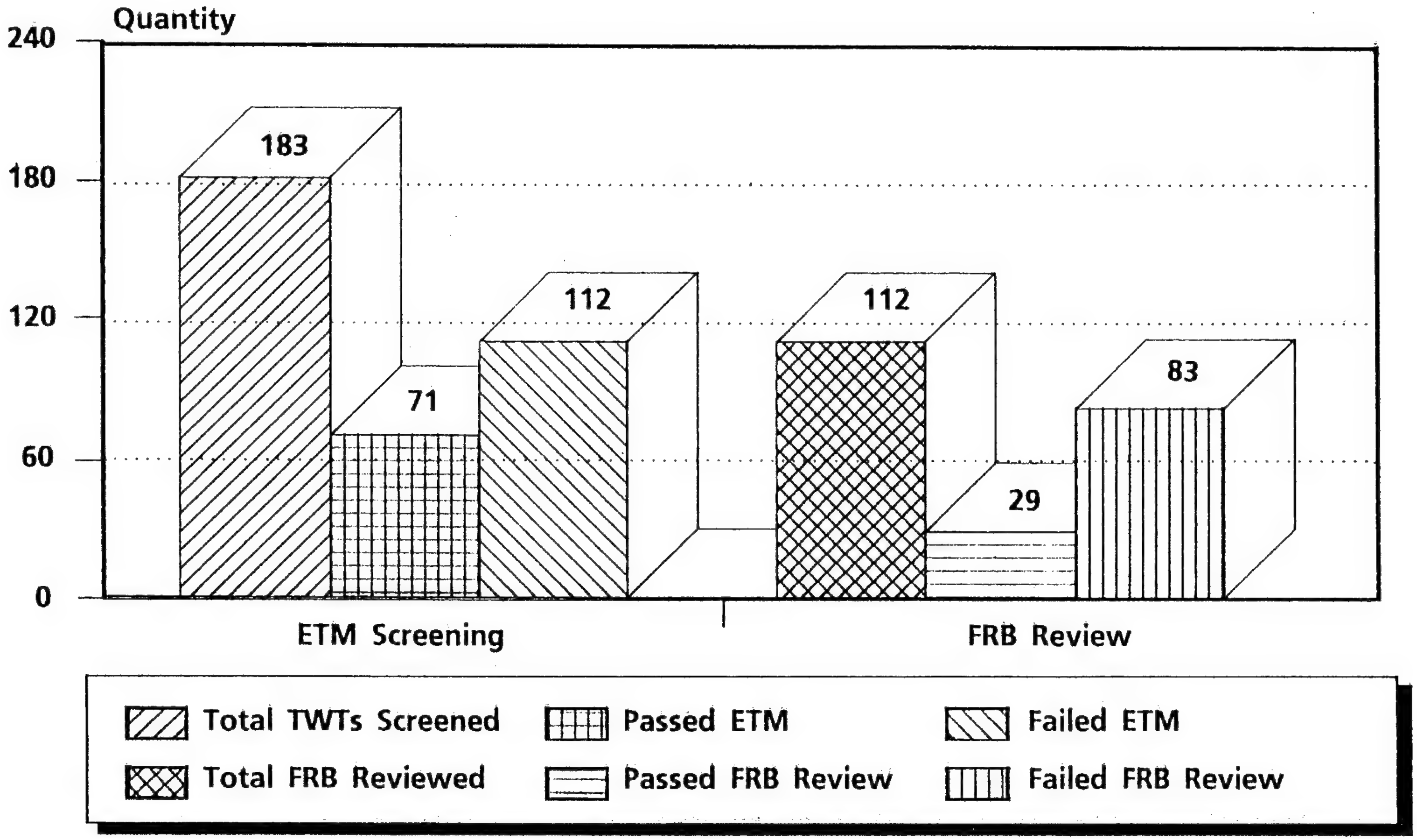
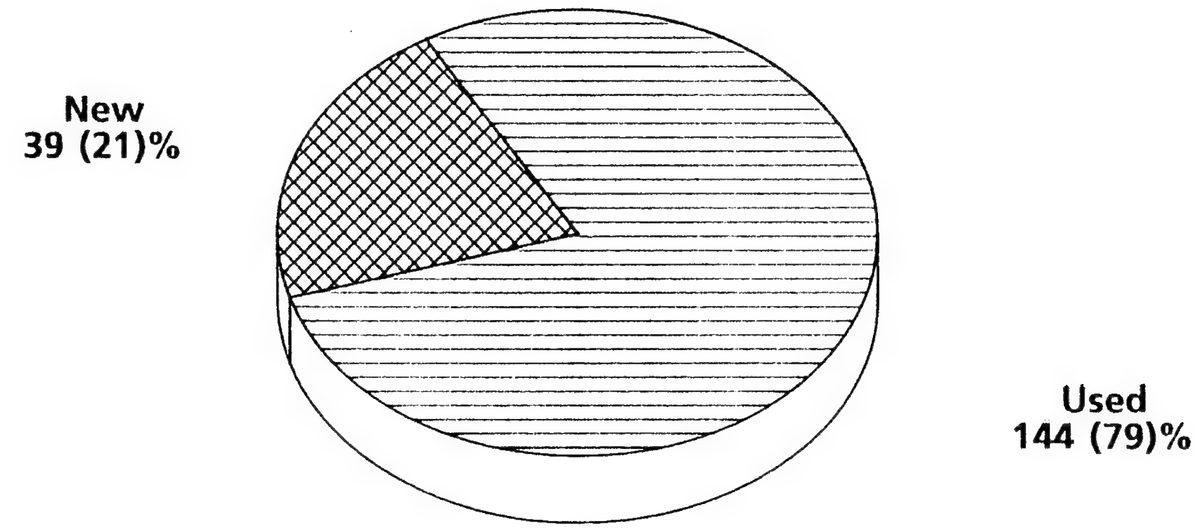


Figure 4.2.4 (b)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 3 TWTs
(New Versus Used)

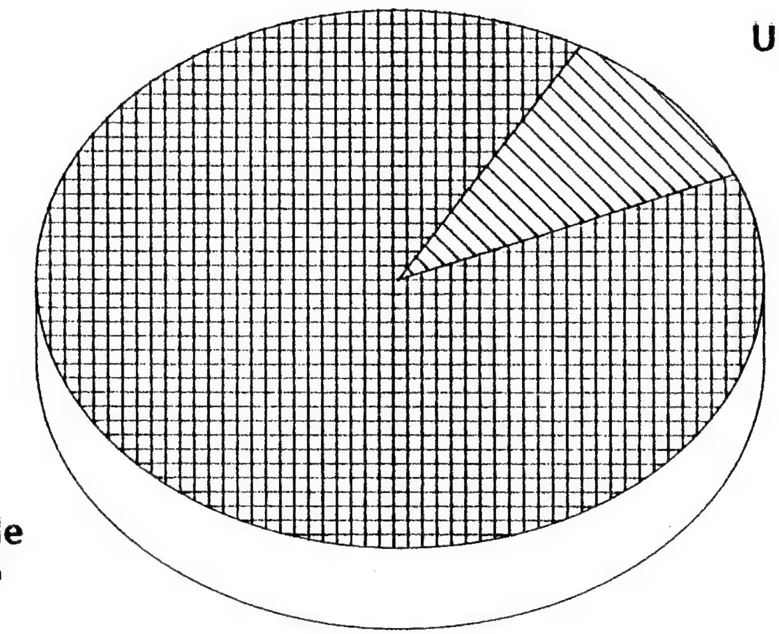


183 Band 3 TWTs Screened

Figure 4.2.4 (c)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 3 TMEC (New) TWTs
(Serviceable vs Unserviceable)



39 Band 3 TMEC
(New) TWTs Screened

Figure 4.2.4 (d)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 3 TMEC (New)
(ETM and FRB Results)

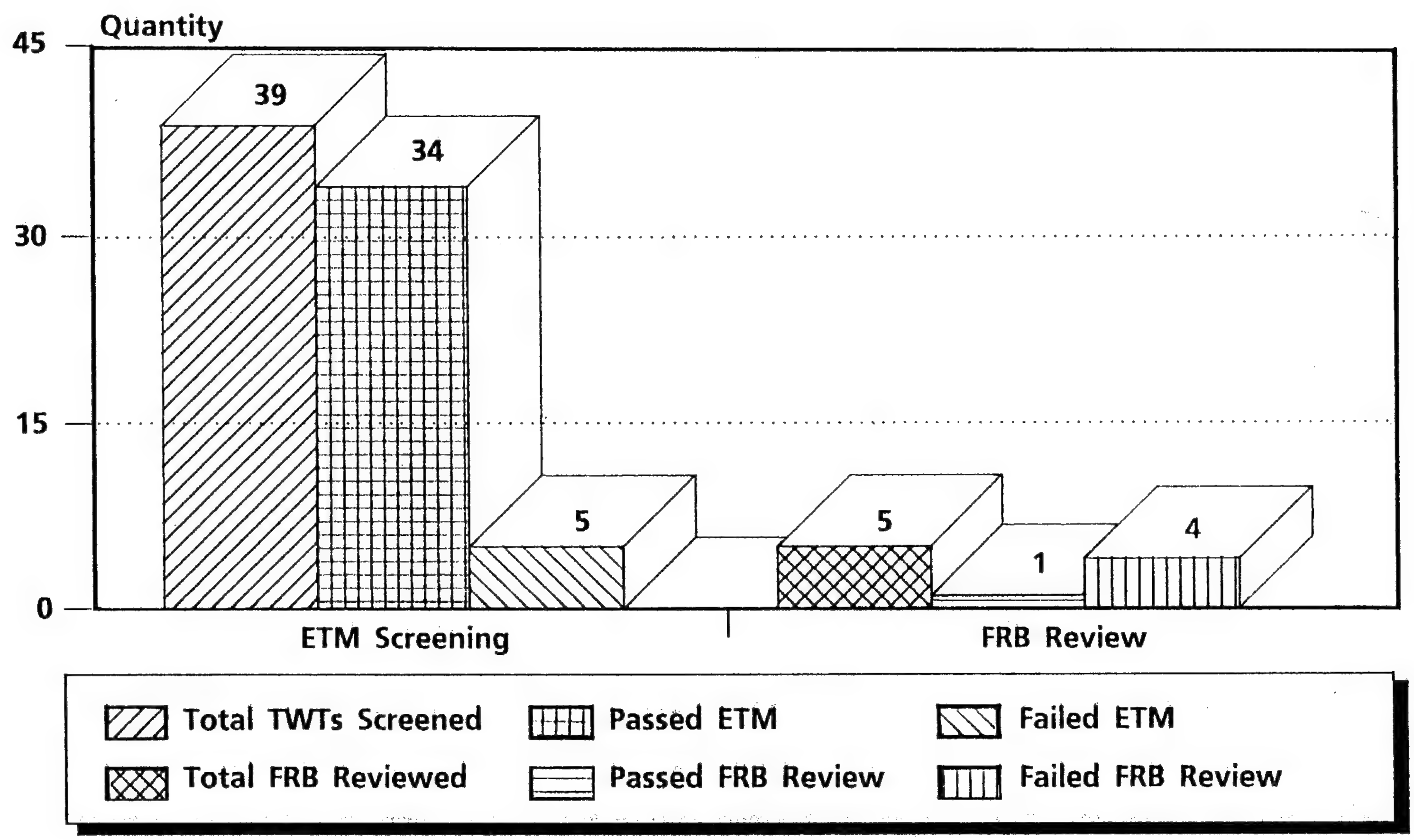


Figure 4.2.4 (e)

Sixty-five (45%) of the 144 used Band 3 TWTs were serviceable and 79 (55%) were unserviceable [Figure 4.2.4 (f)]. Thirty-seven (26%)of the 144 TWTs passed the initial ETM screening, and 107 (74%) were referred to the FRB. Twenty-eight (26%) of the 107 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 4.2.4 (g)]. The Band 3 used TWTs were further broken down into manufacturers, Varian and Litton. One hundred eighteen Varian and 26 Litton TWTs were screened.

Sixty-one (52%) of the 118 used Band 3 Varian TWTs were serviceable and 57 (48%) were unserviceable [Figure 4.2.4 (h)]. Thirty-six (31%) of the 118 TWTs passed initial ETM screening, and 82 (69%) were referred to the FRB. Twenty-five (59%) of the 82 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 4.2.4 (i)]. Four (15%) of the 26 used Band 3 used Litton TWTs were serviceable, and 22 (85%) were unserviceable [Figure 4.2.4 (j)]. One (4%) of the 26 TWTs passed initial ETM screening, and 25 (96%) were referred to the FRB. Three (12%) of the 25 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 4.2.4 (k)].

4.2.5 Band 4 TWTs

Two hundred forty-four (87%) of the 279 new Band 4 output TWTs were serviceable, and 35 (13%) were unserviceable [Figure 4.2.5 (a)]. Two hundred twenty-six (81%) of the 279 TWTs passed the initial ETM screening, and 53 (19%) were referred to the FRB. Eighteen (34%) of the 53 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 4.2.5 (b)].

The 279 new Band 4 TWTs were further broken down into manufacturers. Two hundred seventy-four TWTs were manufactured by Varian and 5 TWTs were manufactured by TMEC. The TMEC TWTs were the only Block II tubes tested. All of the other tubes were Block I.

Two hundred thirty-nine (87%) of the 274 new Band 4 Varian TWTs were serviceable, and 35 (13%) were unserviceable [Figure 4.2.5 (c)]. Two hundred twenty-two (81%) of the 274 TWTs passed the initial ETM screening, and 52 (19%) were referred to the FRB. Seventeen (33%) of the 52 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 4.2.5 (d)].

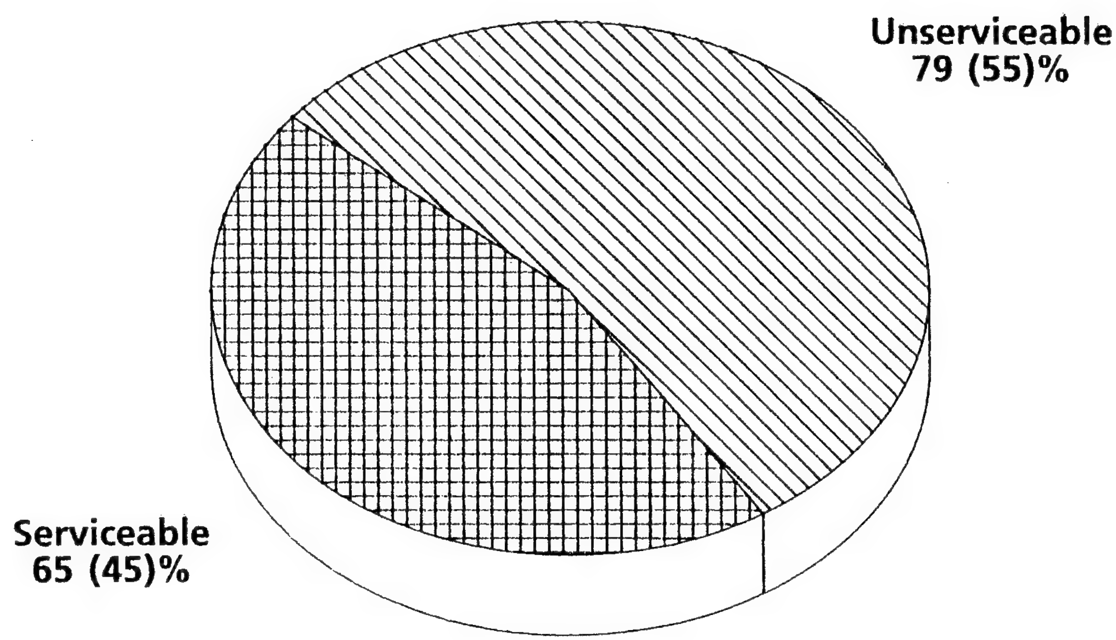
Five (100%) of the new Band 4 TMEC Block II TWTs were serviceable [Figure 4.2.5 (e)]. Four (80%) of the Band 4 TMEC TWTs passed the initial ETM screening, and 1 (20%) was referred to the FRB. The only tube analyzed by the FRB passed and was returned as serviceable [Figure 4.2.5 (f)].

4.2.6 Band 5 TWTs

All 70 of the Band 5 TWTs were new and manufactured by Varian. Sixty-five (93%) of the new Band 5 output TWTs were serviceable and 5 (7%) were unserviceable [Figure 4.2.6 (a)]. Fifty-six (80%) of the 70 TWTs passed the initial ETM screening, and 14 (20%) were referred to the FRB. Nine (64%) of the 14 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 4.2.6 (b)].

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 3 (Used) TWTs
(Serviceable vs Unserviceable)



144 Band 3
(Used) TWTs Screened

Figure 4.2.4 (f)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 3 Used
(ETM and FRB Results)

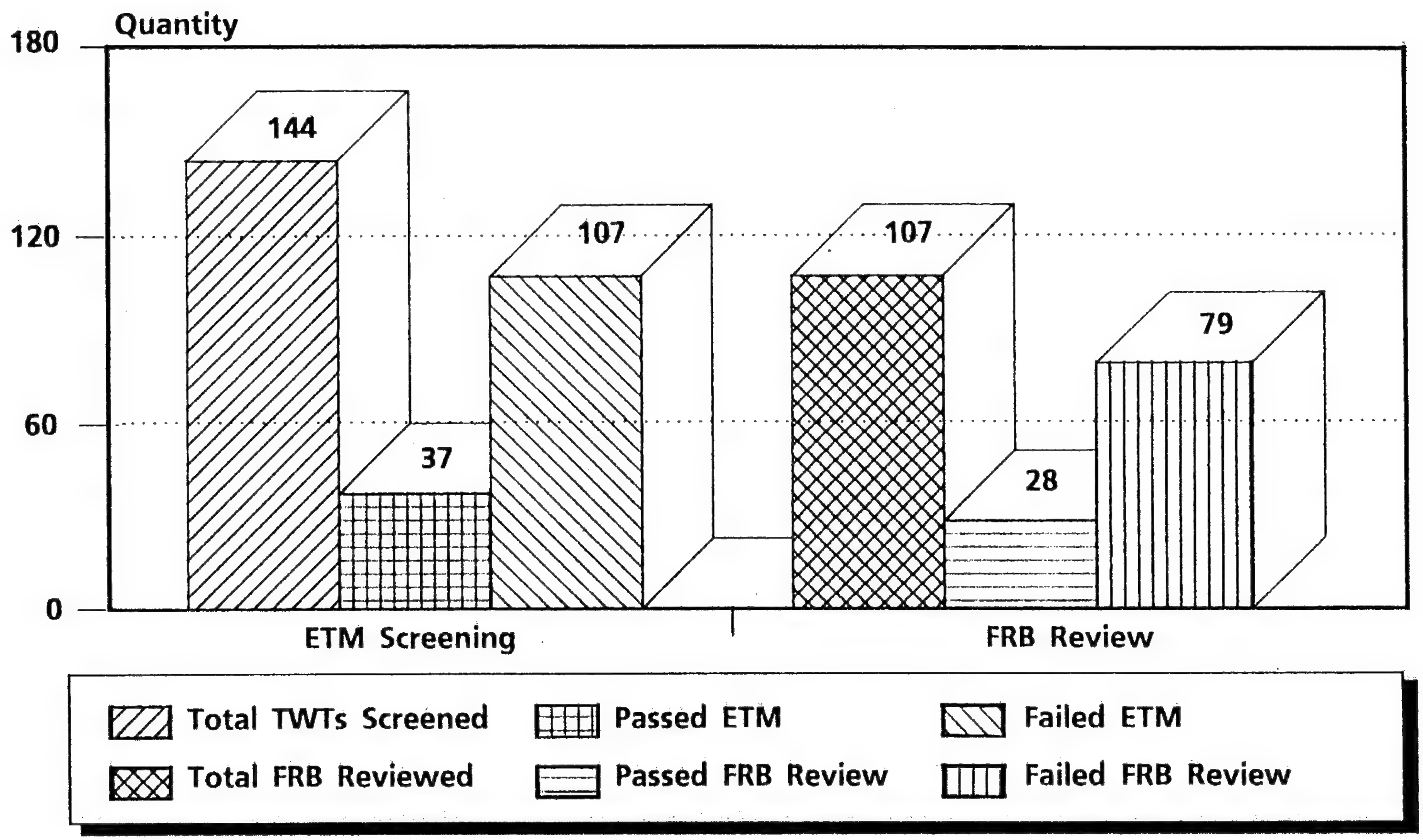
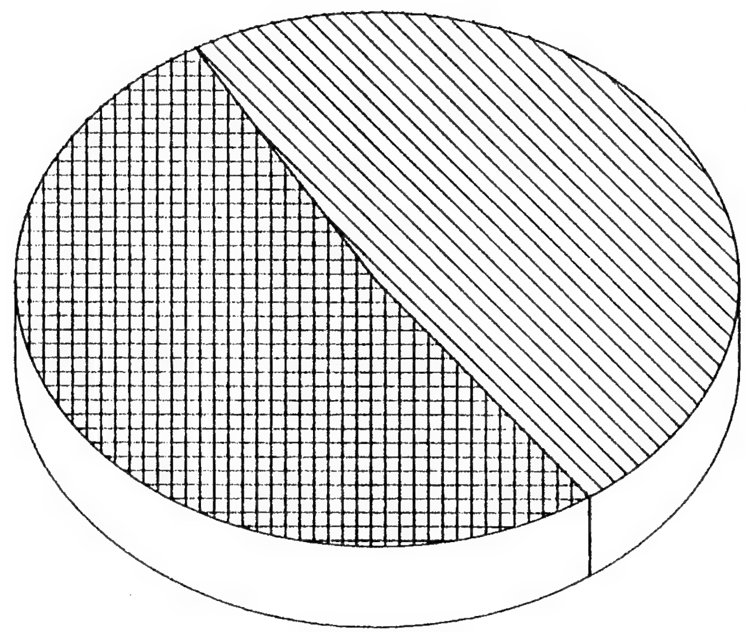


Figure 4.2.4 (g)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 3 (Used) TWTs
(Serviceable vs Unserviceable)



118 Band 3 Varian
(Used) TWTs Screened

Figure 4.2.4 (h)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 3 Varian (Used)
(ETM and FRB Results)

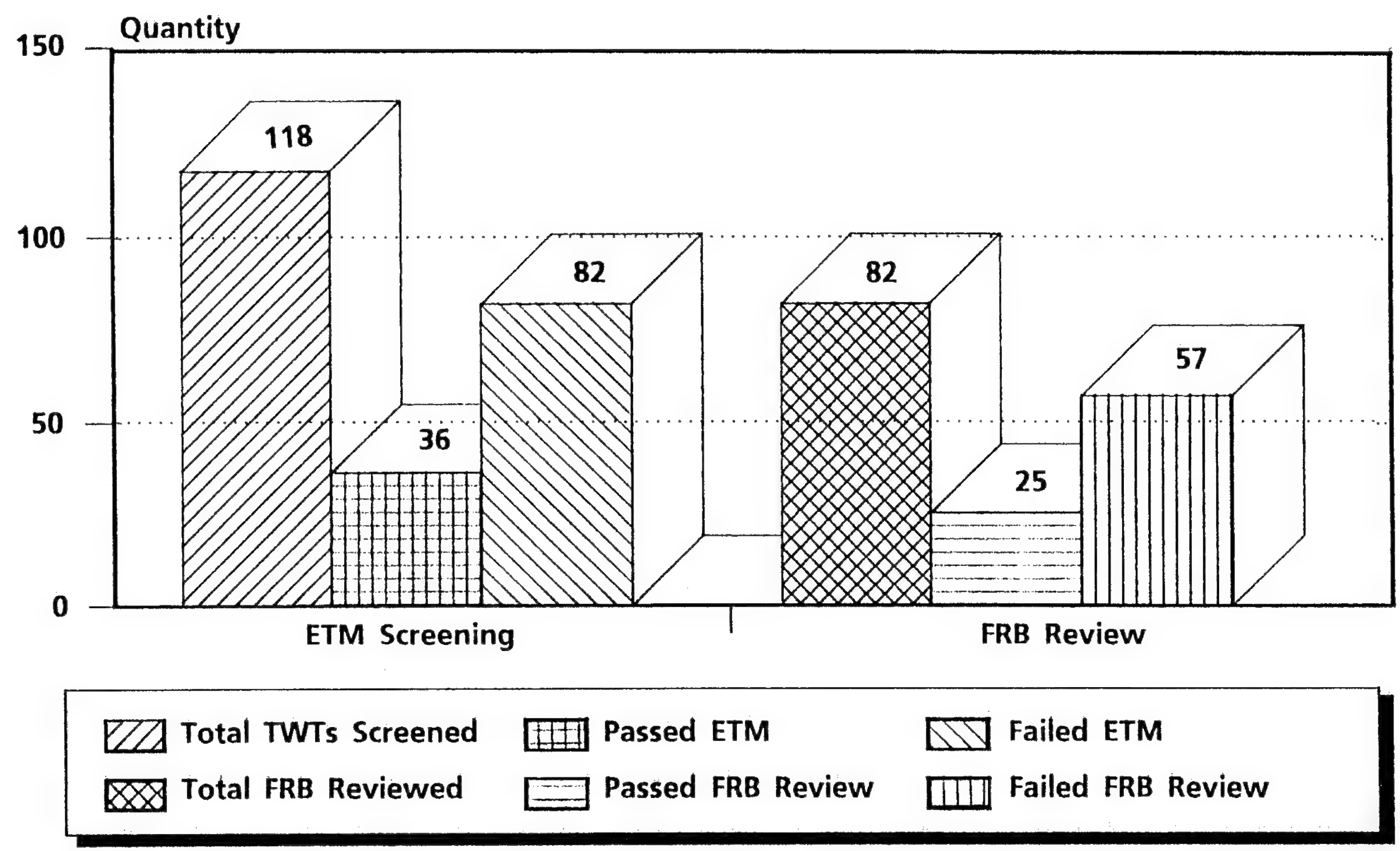
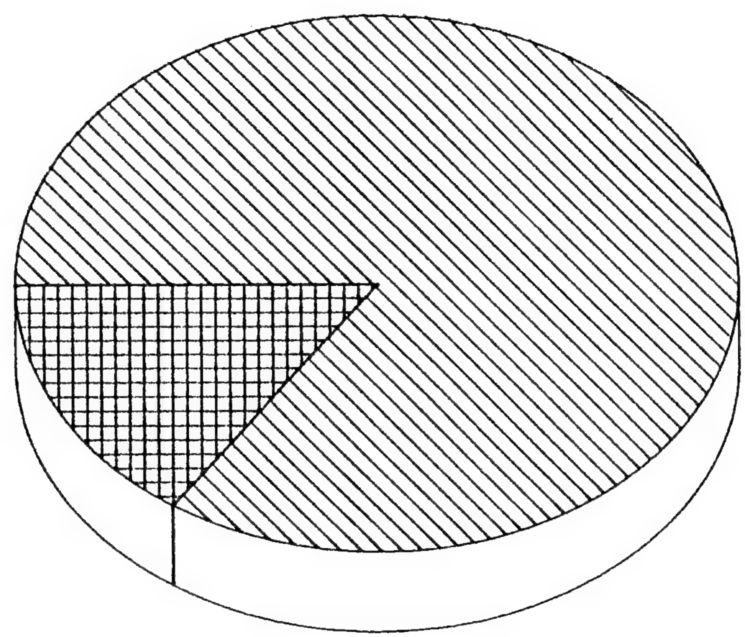


Figure 4.2.4 (i)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 3 Litton (Used)
(Serviceable vs Unserviceable)



26 Band 3 Litton (Used) TWTs Screened

Figure 4.2.4 (j)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Used TWTs Screened (ETM and FRB Results)

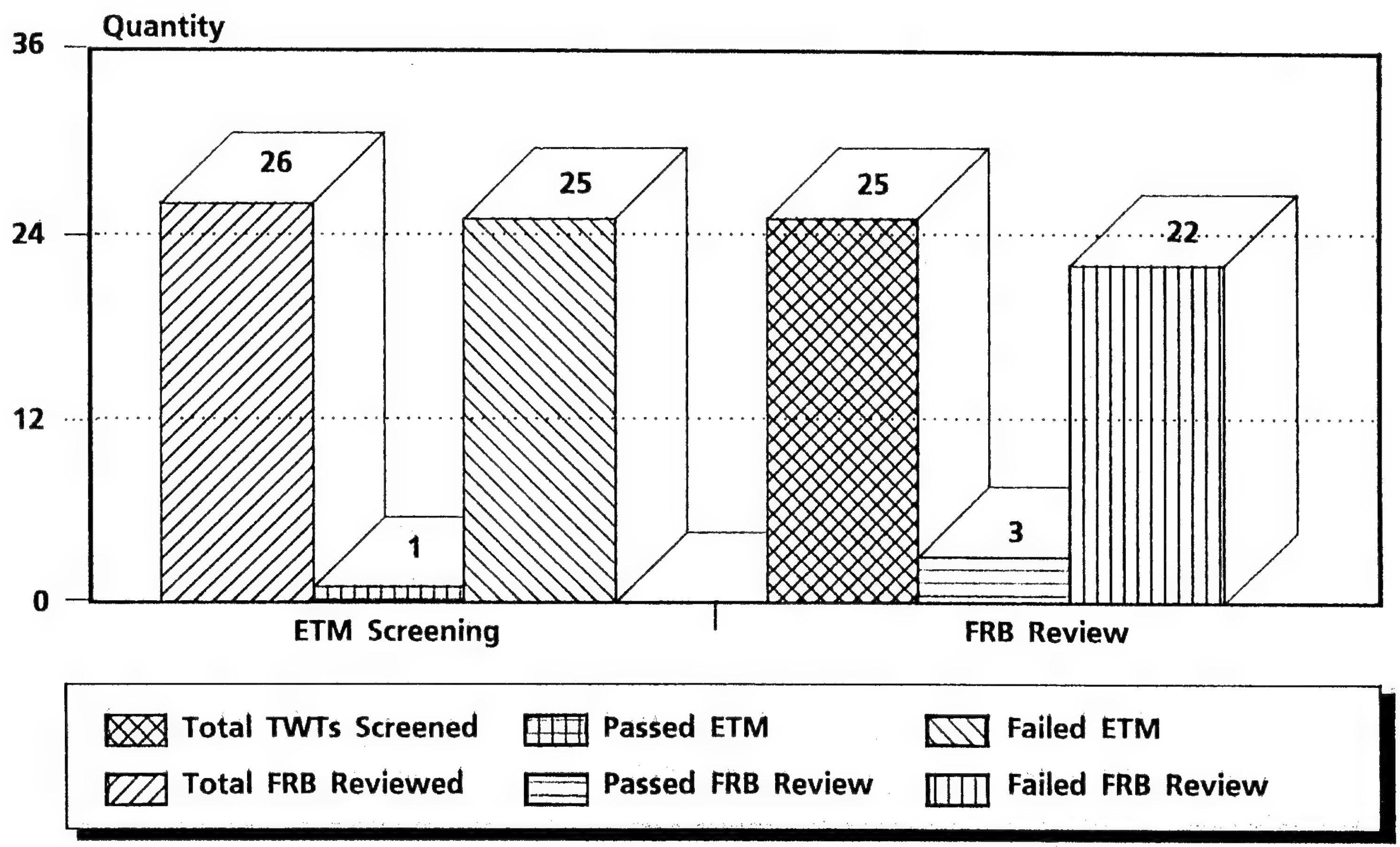
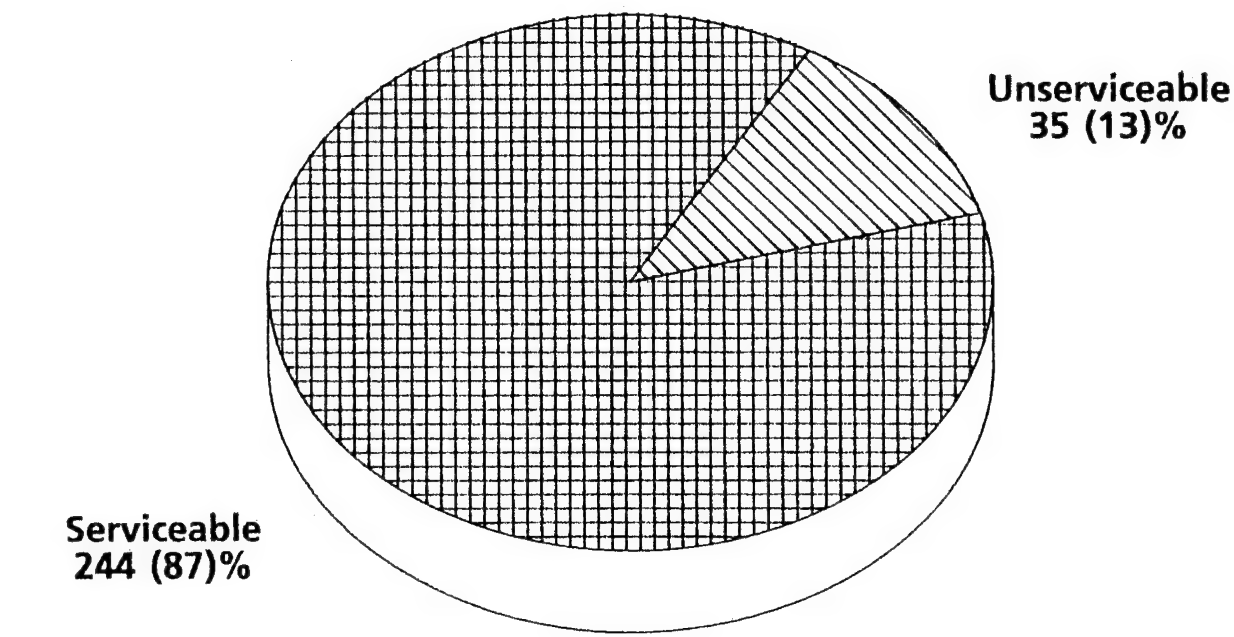


Figure 4.2.4 (k)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 4 TWTs Screened
(Serviceable vs Unserviceable)



279 Band 4 (New)
TWTs Screened

Figure 4.2.5 (a)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 4 TWTs Screened
(ETM and FRB Results)

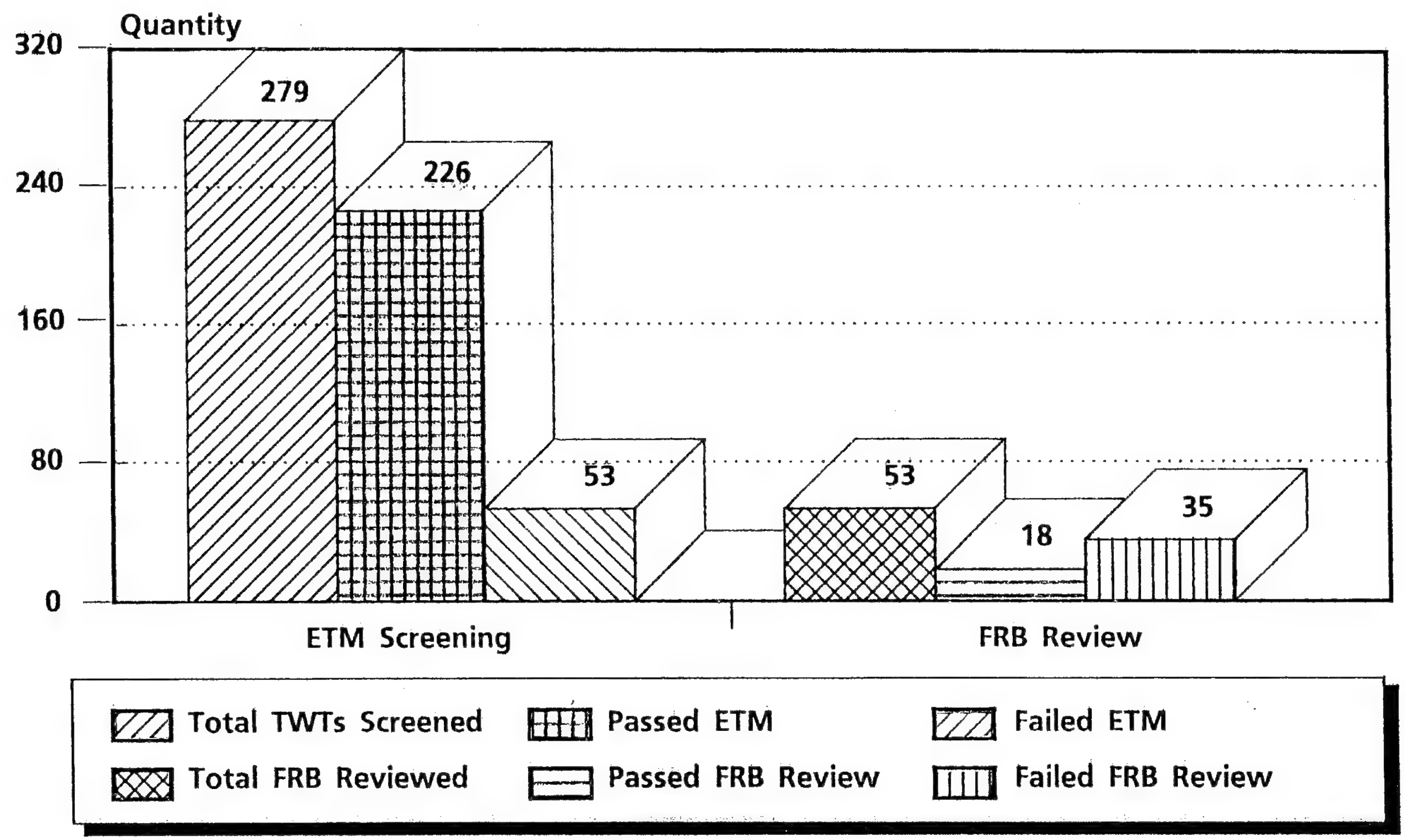
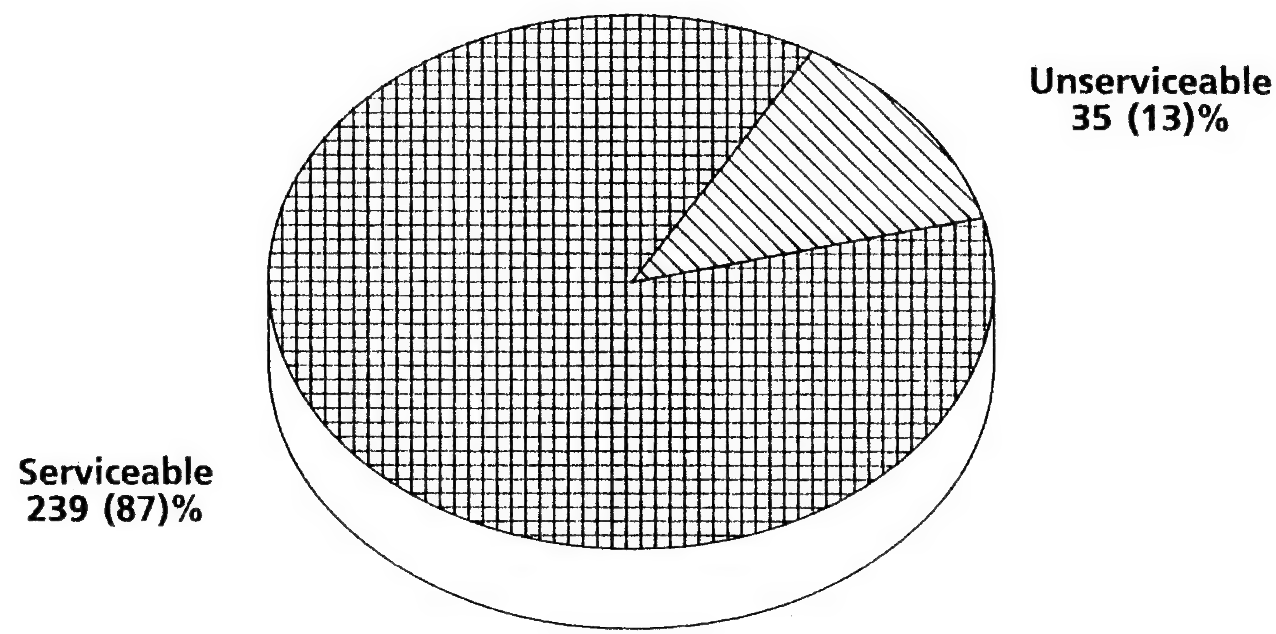


Figure 4.2.5 (b)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 4 Varian (New)
(Serviceable vs Unserviceable)



274 Band 4 Varian
(New) TWTs Screened

Figure 4.2.5 (c)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 4 Varian (New)
(ETM and FRB Results)

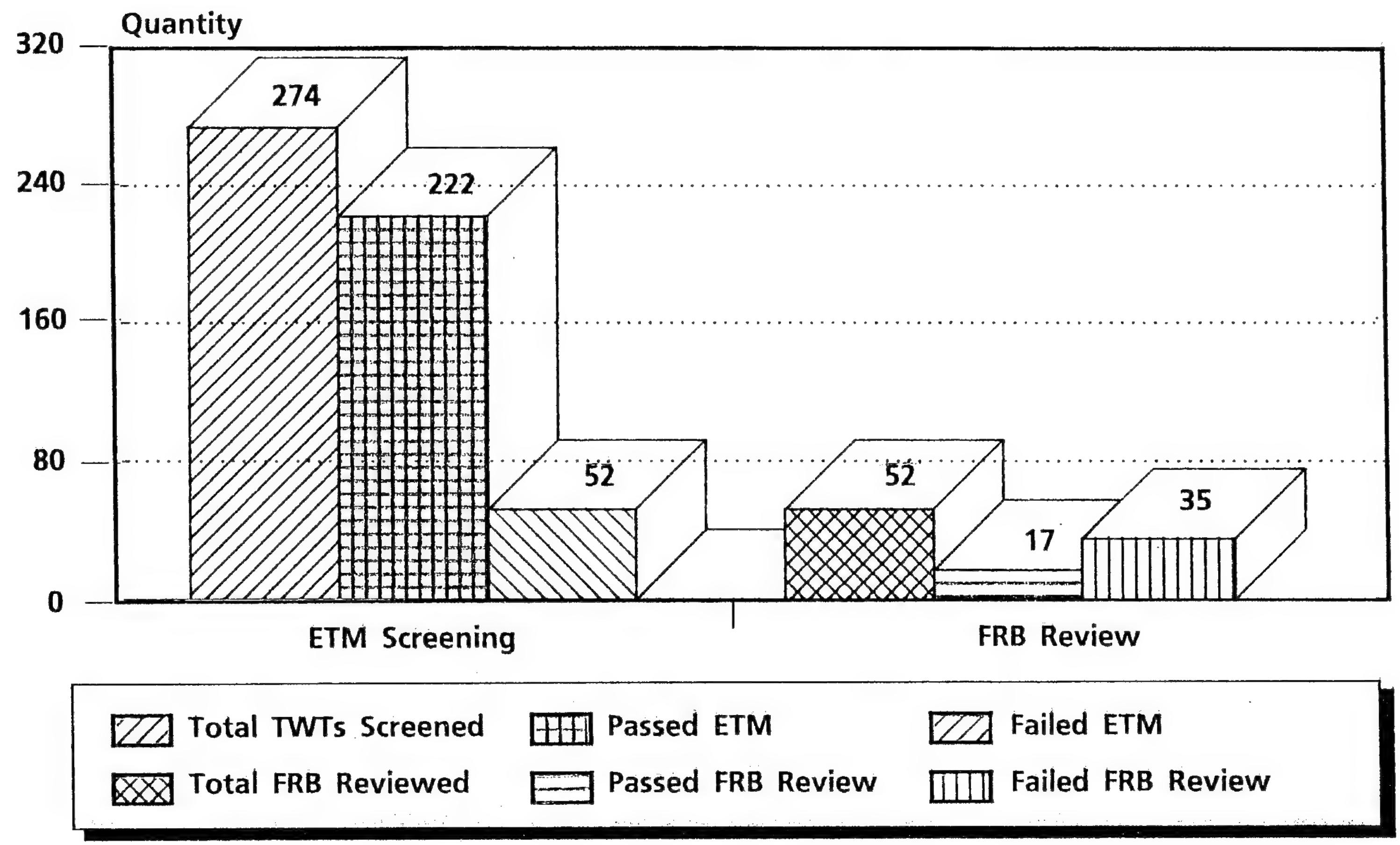
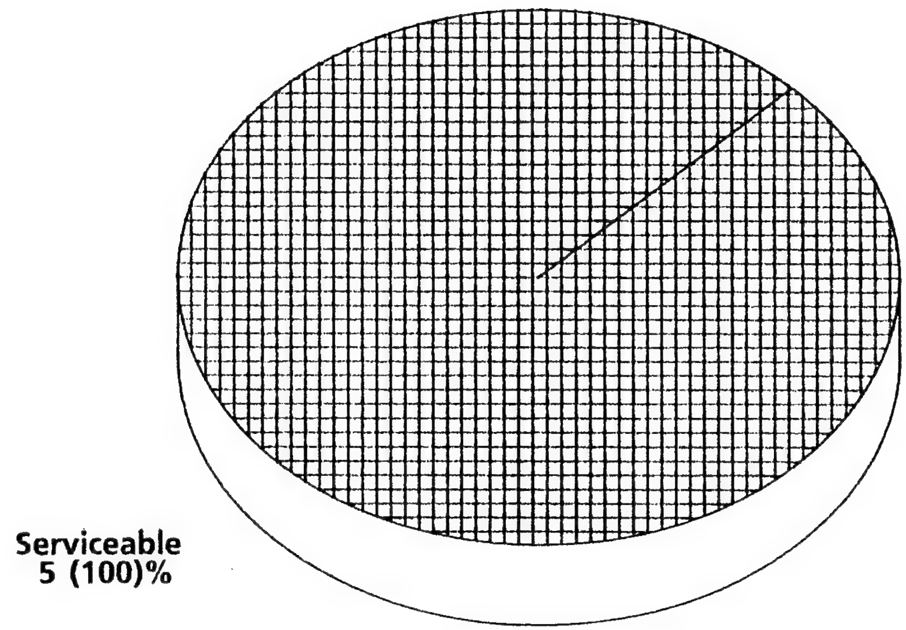


Figure 4.2.5 (d)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 4 TMEC (New)
(Serviceable vs Unserviceable)



5 Band 4 TMEC (New)
Output TWTs Screened

Figure 4.2.5 (e)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 4 TMEC (New)
(ETM and FRB Results)

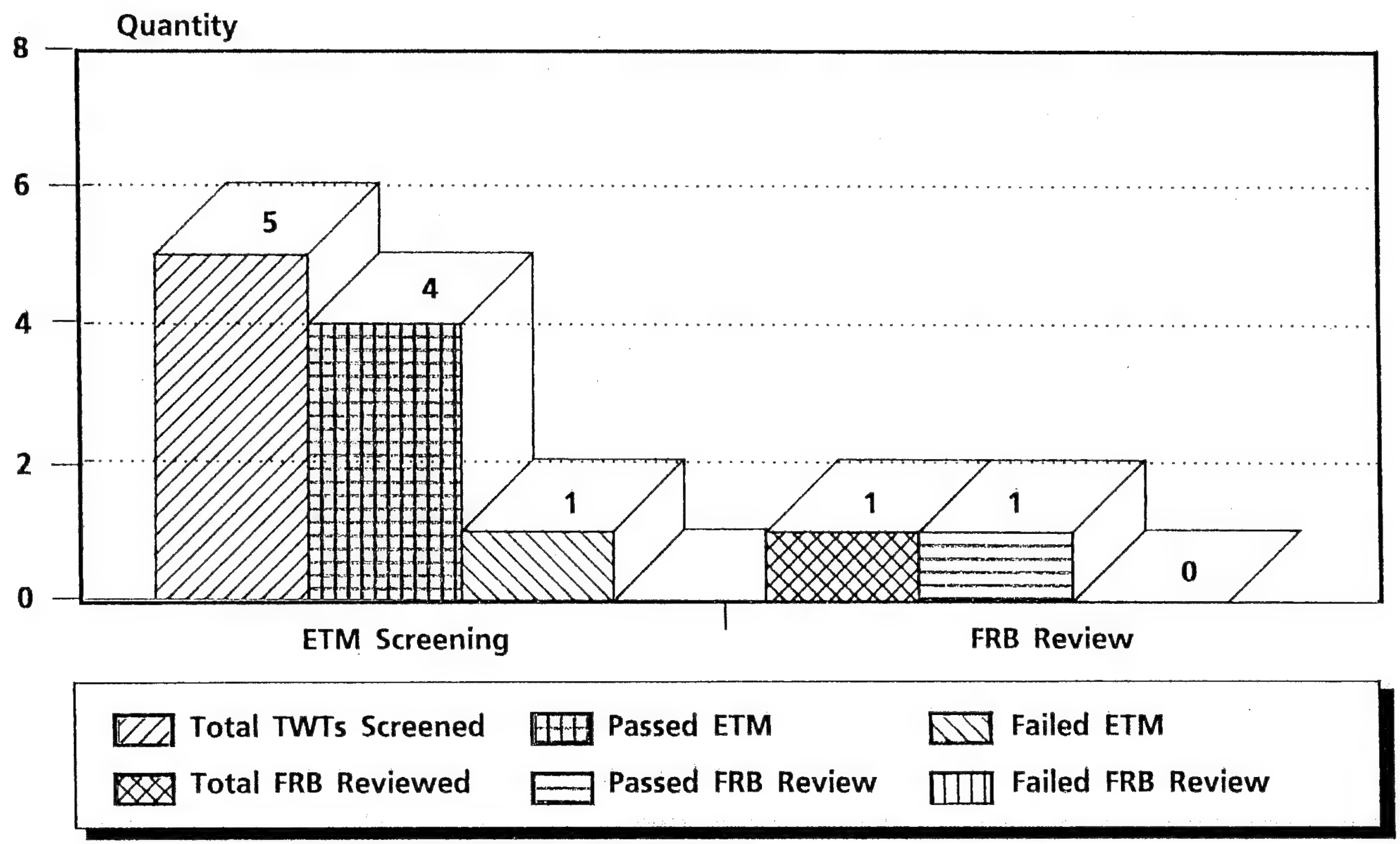
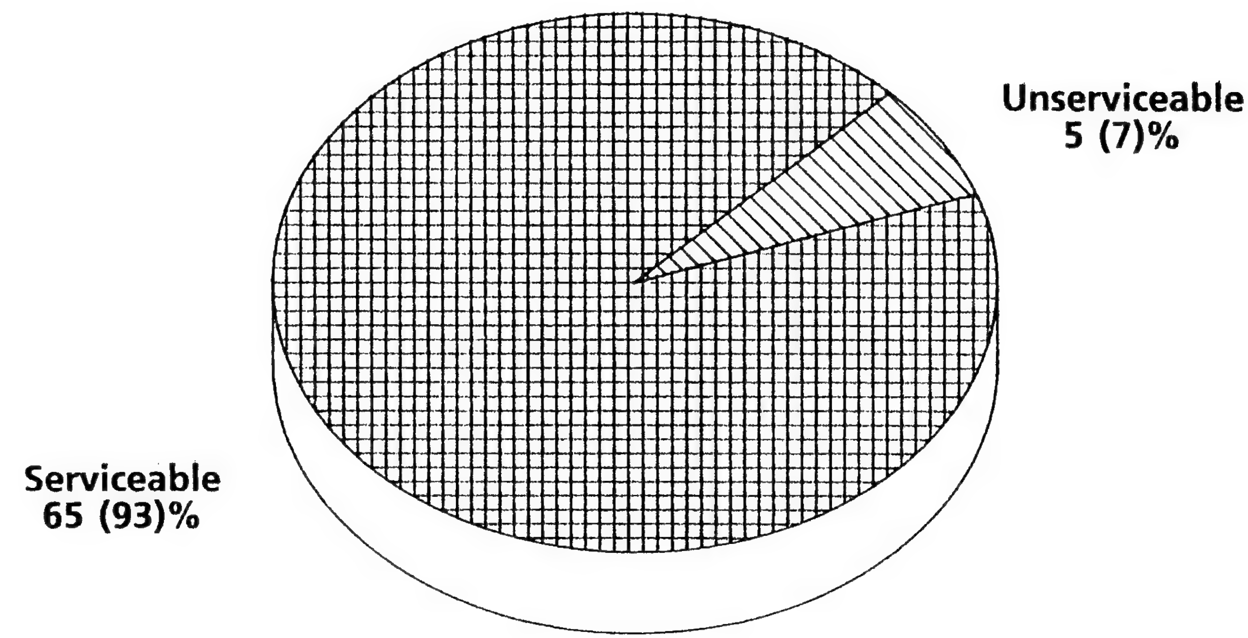


Figure 4.2.5 (f)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 4 Varian (New)
(Serviceable vs Unserviceable)



70 Band 4 Varian
(New) TWTs Screened

Figure 4.2.6 (a)

AN/ALQ-131 OUTPUT TWTs

Program Summary: Band 5 Varian TWTs
(ETM and FRB Results)

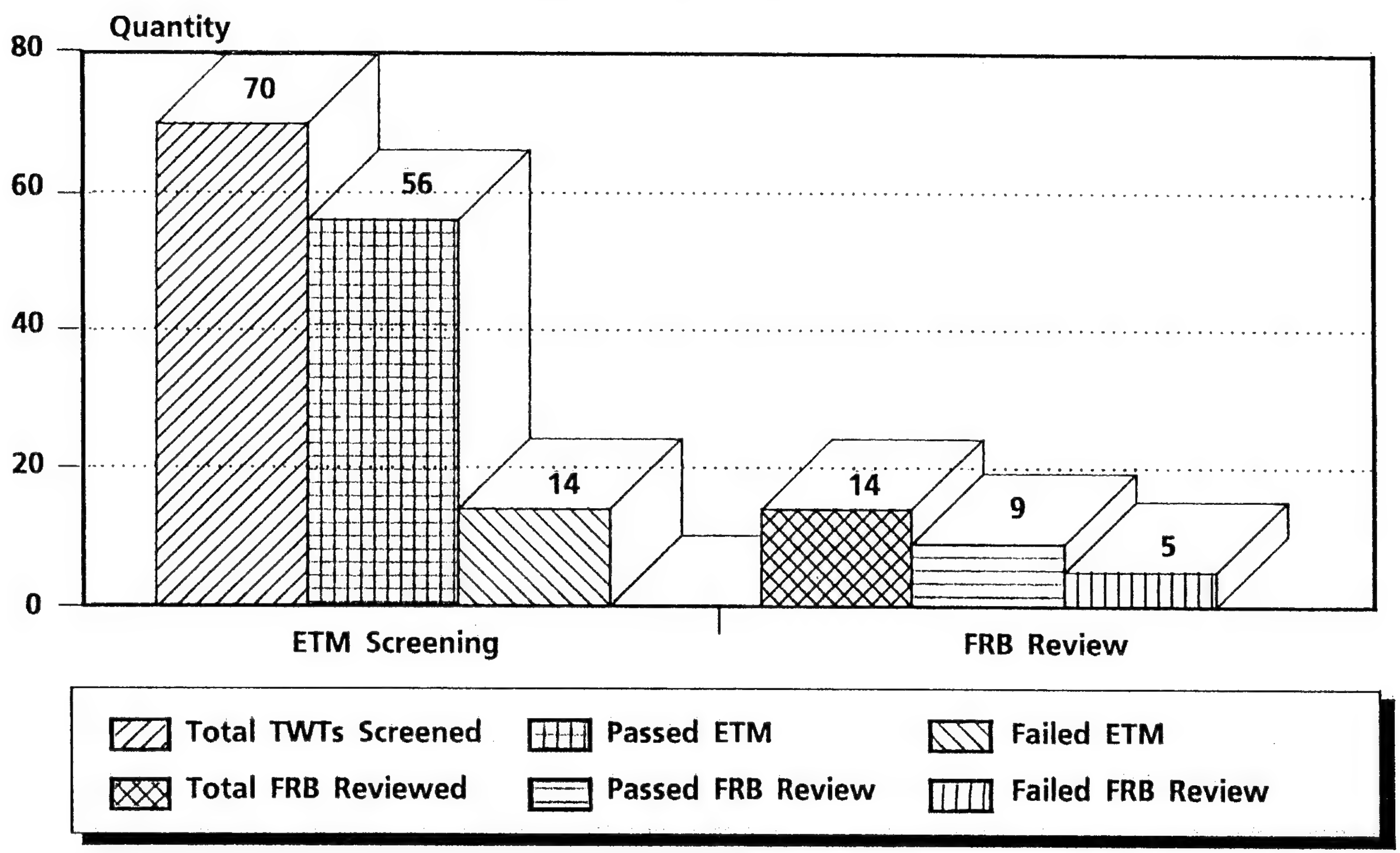


Figure 4.2.6 (b)

5.0 TEST SUMMARY - DRIVER TWTS

5.1 Description

The second type of TWT tested was the driver TWT (TWT) or traveling wave tube amplifiers (TWTA). The TWT consisted of two TWTs and an integral power supply. The driver TWTs are wide band, low noise, and are of glass construction. The power outputs were in the range of 0.5 to 5 watts. The Block I uses a TWT in all three bands, while the Block II has a TWT in only Band 3. Solid state RF amplifiers have replaced the driver TWT in Bands 4 and 5 in the Block II.

5.2 Test Results

A total of 514 driver TWTs were screened at the Warner Robins Regional Service Center from January 1990 through December 1990. All of the driver TWTs were manufactured by Litton and consisted of bands 3, 4, and 5 as well as new and used tubes [Table 5.2 (a)]. All of the driver TWTs were screened in accordance to the test procedures outlined in paragraph 2.2.2. A summary of the laboratory bench test results is depicted in Table 5.2 (b). The TWTs that failed on a case-by-case basis. If it was determined that the TWT would pass the AN/ALQ-131 system test, then it was categorized a serviceable [Table 5.2 (c)]. The total number of serviceable TWTs returned to the USAF was a combination of the tubes that passed the bench test and the tubes that passed the FRB analysis [Table 5.2 (d)].

5.2.1 Program Results

From the 514 TWTs screened, 298 (58%) were serviceable, 22 (4%) were unserviceable, and 194 (38%) are being held for further study [Figure 5.2.1 (a)]. Two hundred twenty (43%) of the 514 TWTs screened passed the initial bench test, and 294 (57%) were referred to the FRB for analysis. Seventy-eight (27%) of the 294 TWTs analyzed by the FRB passed and were returned as serviceable. Twenty-two (7%) were returned as unserviceable, and 194 (66%) are being held at the Regional Service Center pending further study [Figure 5.2.1 (b)].

5.2.2 New Versus Used TWTs

The driver TWTs were broken down into two categories, new and used. The new TWTs were tubes that were still in the original manufacturer's shipping containers. The used TWTs were tubes that had previously failed in the field and had been returned to the USAF supply system as serviceable. A total of 450 (88%) of the driver TWTs were new and 64 (12%) were used [Figure 5.2.2 (a)]. Two hundred fifty (56%) of the 450 new driver TWTs were serviceable, 6 (1%) were unserviceable, and 194 (43%) are being held pending further study [Figure 5.2.2 (a)]. One hundred ninety (42%) of the 450 new TWTs passed the initial bench test, and 260 (58%) were referred to the FRB. Sixty (23%) of the 260 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 5.2.2 (b)].

Vendor	Part Number	Stock Number	Band	New/Used
Litton	581R278H02	5865-01-045-6754EW	3	Used
Litton	581R279H02	5865-01-072-3490EW	4	New
Litton	581R280H04	5865-01-054-4781EW	5	New

Table 5.2 (a) Types of Driver TWTs Screened

Vendor	Band	Quantity Screened	Quantity Passed	Quantity Failed
Litton	3	64	30 (46.9%)	34 (53.1%)
Litton	4	150	36 (30.5%)	31 (20.7%)
Litton	5	300	119 (79.3%)	229 (76.3%)
Totals:		514	71 (23.7%)	294 (57.2%)

Table 5.2 (b) Driver TWT Laboratory Results

Vendor	Band	New/ Used	Quantity Reviewed	Quantity Passed	Quantity Failed
Litton	3	Used	34	18 (52.9%)	16 (47.1%)
Litton	4	New	31	29 (93.5%)	2 (6.5%)
Litton	5	New	229	31 (13.5%)	198 (86.5%)
Totals:			294	78 (26.5%)	216 (73.5%)

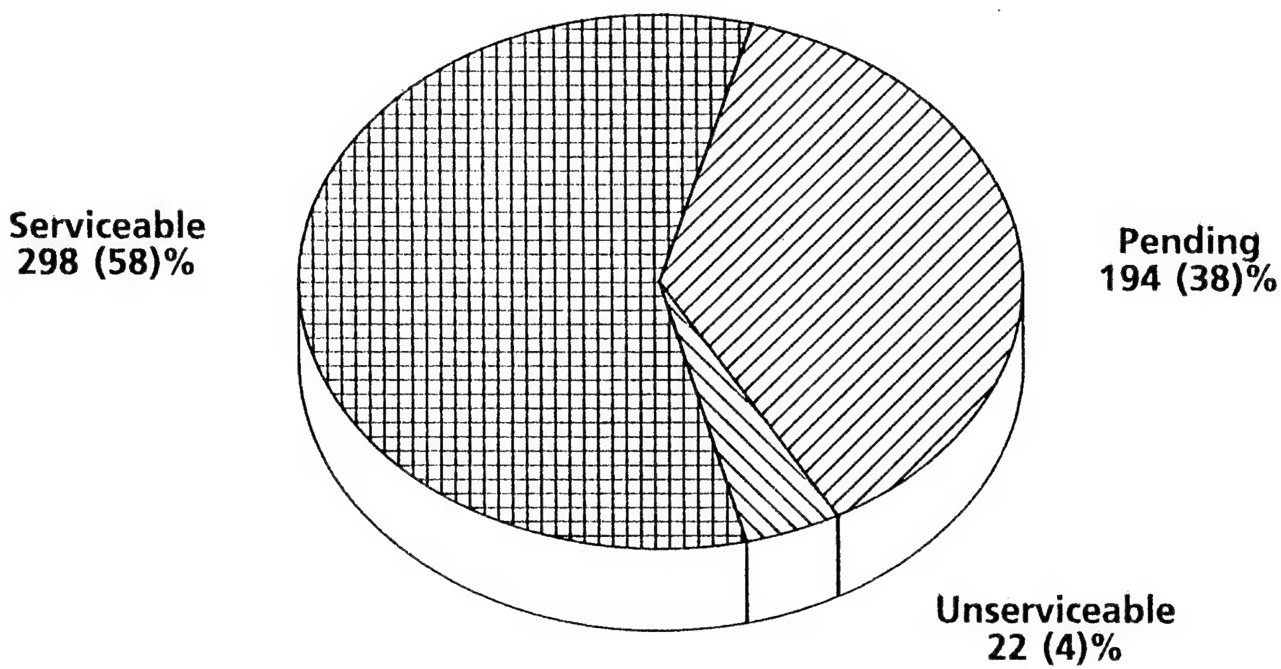
Table 5.2 (c) FRB Results for Driver TWTs

Vendor	Band	New/ Used	Quantity Screened	Quantity Serviceable
Litton	3	Used	64	48 (75.0%)
Litton	4	New	150	148 (98.7%)
Litton	5	New	300	102 (34.0%)
Totals:			514	298 (58.0%)

Table 5.2 (d) Program Results for Driver TWTs

AN/ALQ-131 DRIVER TWTs

Program Summary: Total TWTs Screened
(Serviceable Versus Unserviceable)



514 Driver TWTs Screened

Figure 5.2.1 (a)

Forty-eight (75%) of the 64 used TWTs were serviceable and 16 (25%) were unserviceable [Figure 5.2.2 (a)]. Thirty (47%) of the 64 used TWTs passed the initial bench test, and 34 (53%) were referred to the FRB. Eighteen (53%) of the 34 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 5.2.2 (c)].

5.2.3 Bands

The driver TWTs were further broken down into three (3) bands. There were 64 (12.5%) Band 3 TWTs, 150 (29.2%) Band 4 TWTs, and 300 (58.4%) Band 5 TWTs screened on the laboratory test bench [Figure 5.2.3 (a)].

5.2.4 Band 3 TWTs

There were 64 Band 3 driver TWTs screened. Forty-eight (75%) of the 64 Band 3 TWTs were serviceable and 16 (25%) were unserviceable [Figure 5.3.4 (a)]. Thirty (47%) of the 64 TWTs passed the initial bench test, and 34 (53%) were referred to the FRB. Eighteen (53%) of the 34 TWTs analyzed by the FRB were passed and returned as serviceable, and 16 (47%) were returned as unserviceable [Figure 5.2.4 (b)].

5.2.5 Band 4 TWTs

One hundred forty-eight (99%) of the 150 new Band 4 driver TWTs were serviceable and 2 (1%) were unserviceable [Figure 5.2.5 (a)]. One hundred nineteen (79%) of the 150 TWTs passed the initial bench test, and 31 (21%) were referred to the FRB. Twenty-nine (94%) of the 31 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 5.2.5 (b)].

5.2.6 Band 5 TWTs

One hundred two (34%) of the new Band 5 driver TWTs were serviceable, 4 (1%) were unserviceable, and 194 (65%) are being held at the Regional Service Center pending further study [Figure 5.2.6 (a)]. The TWTs being held are failing the bench test due to first stage problems. Refer to paragraph 8.4 for additional information on this problem. Seventy-one (24%) of the 300 TWTs passed the initial bench test, and 229 (76%) were referred to the FRB. Thirty-one (14%) of the 229 TWTs analyzed by the FRB passed and were returned as serviceable [Figure 5.2.6 (b)].

AN/ALQ-131 DRIVER TWTs

Program Summary: Total TWTs Screened
(Bench Test and FRB Results)

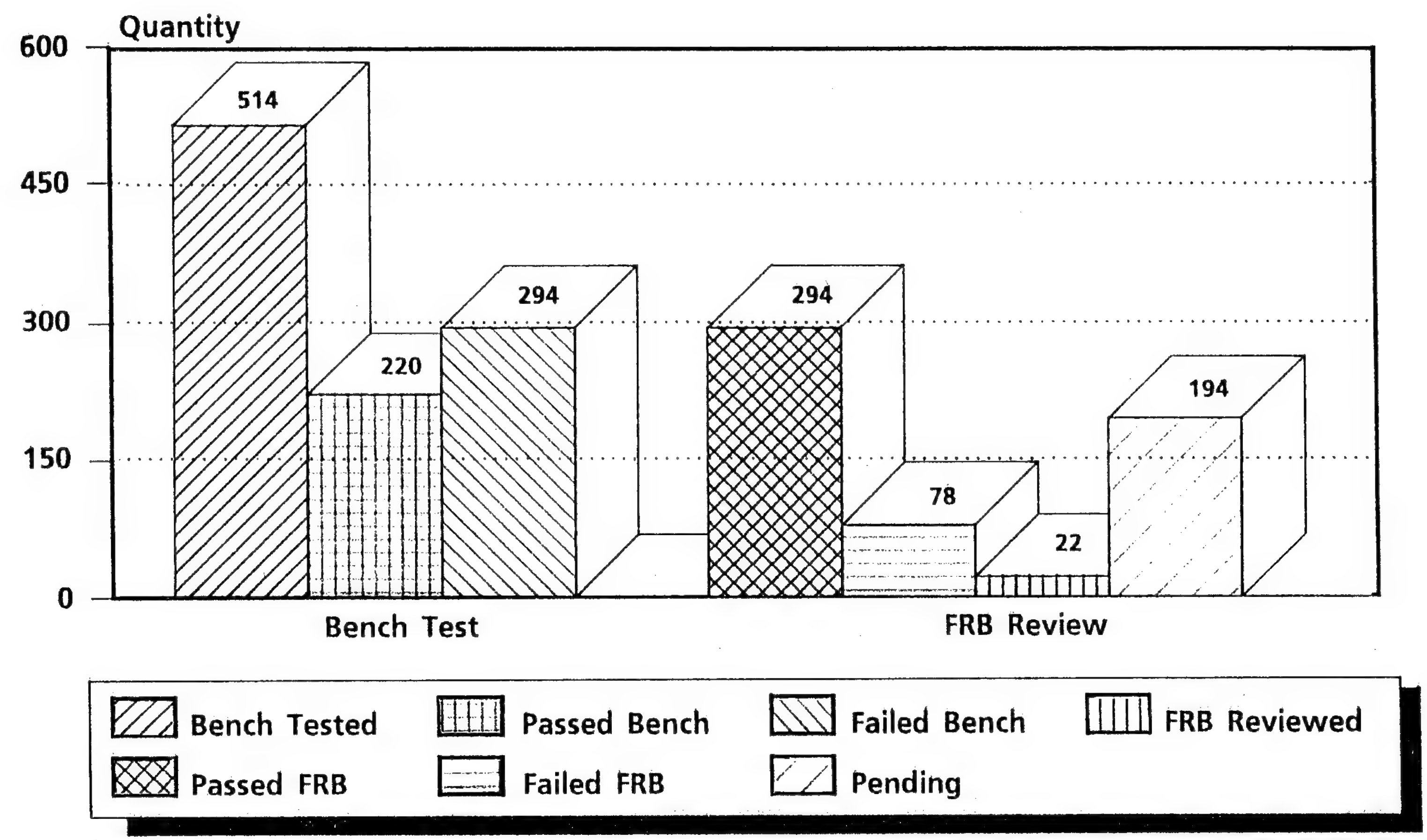


Figure 5.2.1 (b)

AN/ALQ-131 DRIVER TWTs

Program Summary: Total New Versus Used (Serviceable Versus Unserviceable)

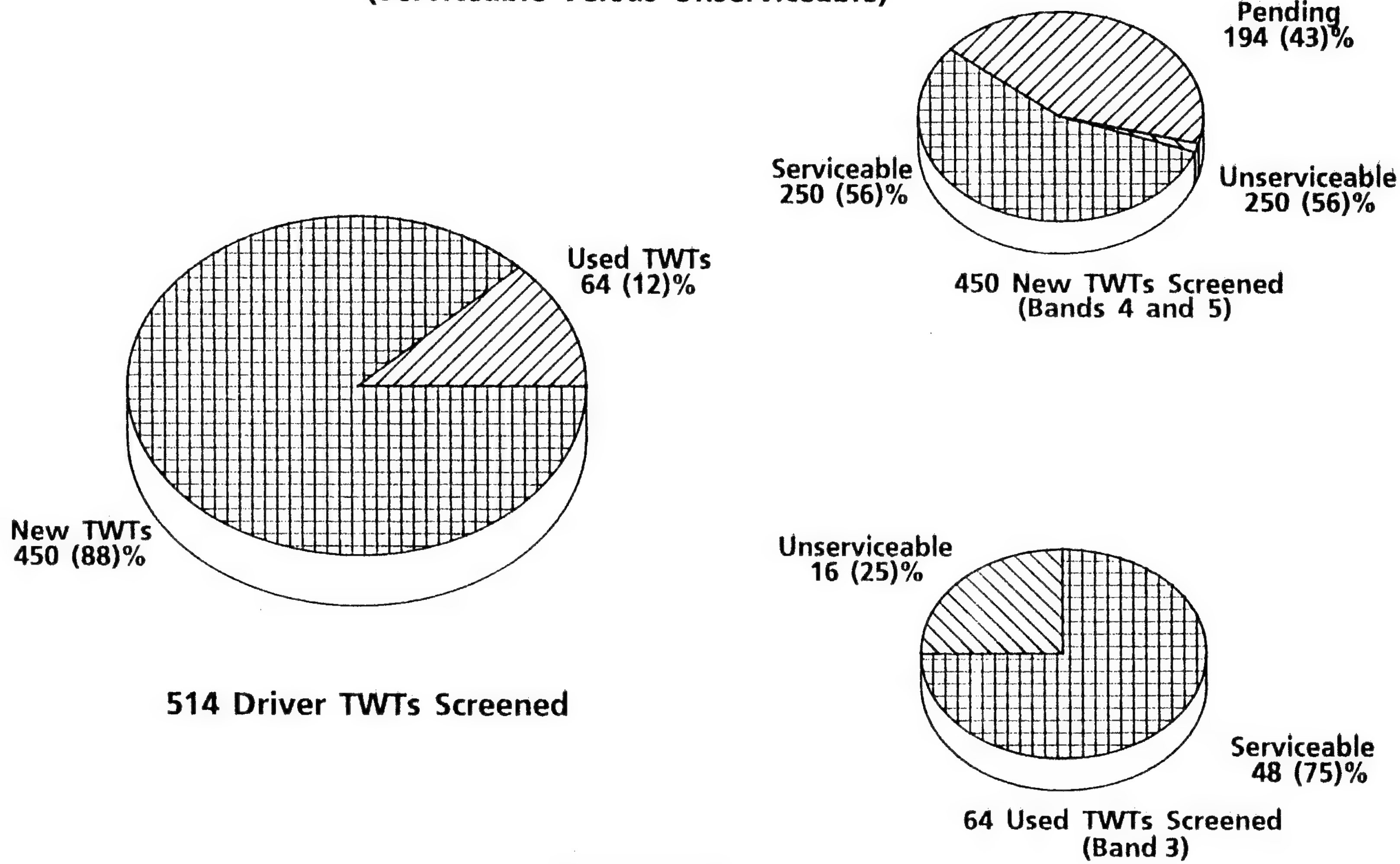


Figure 5.2.2 (a)

AN/ALQ-131 DRIVER TWTs

Program Summary: Total TWTs Screened
(Bench Test and FRB Results)

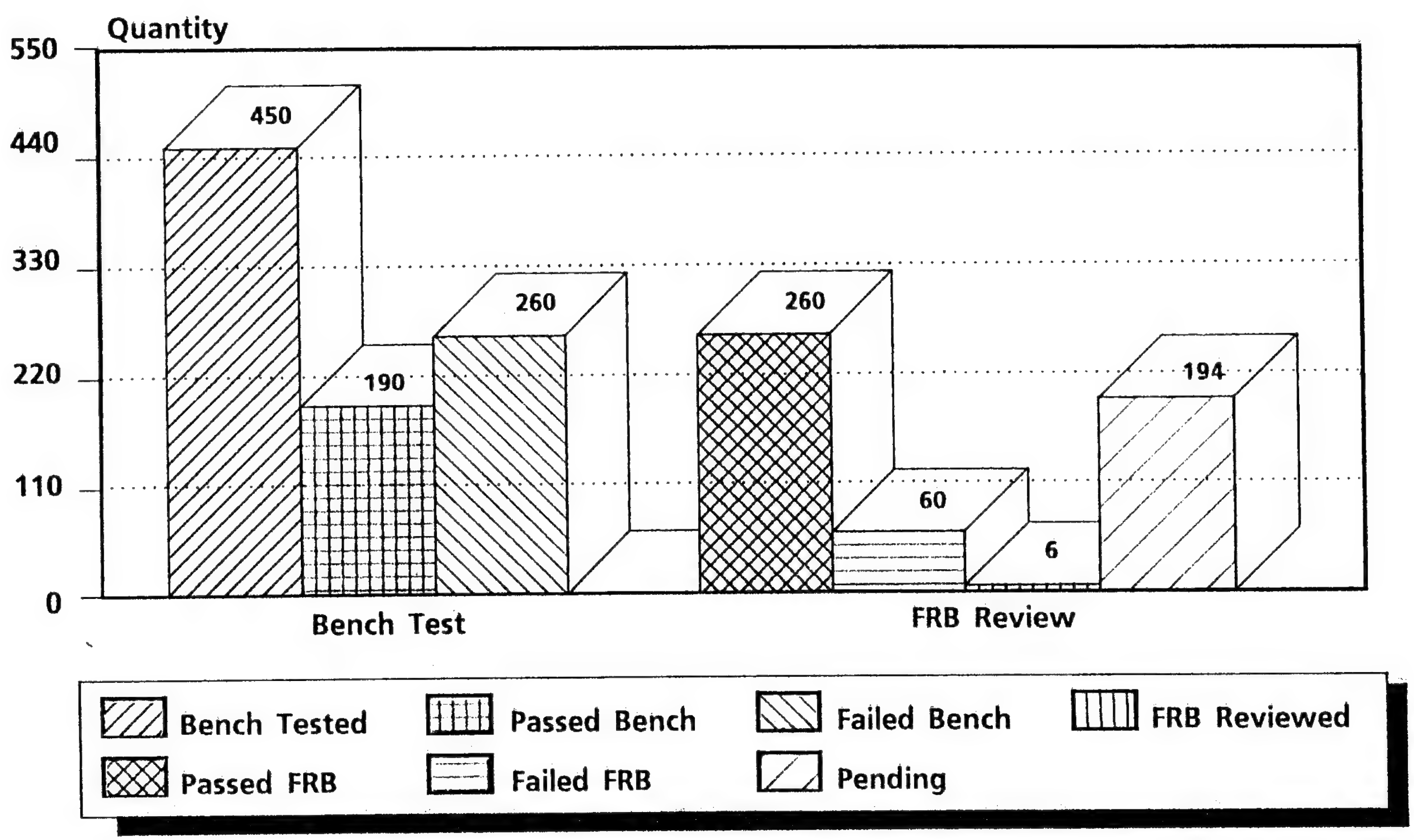


Figure 5.2.2 (b)

AN/ALQ-131 DRIVER TWTs

Program Summary: Used TWTs Screened
(Bench Test and FRB Results)

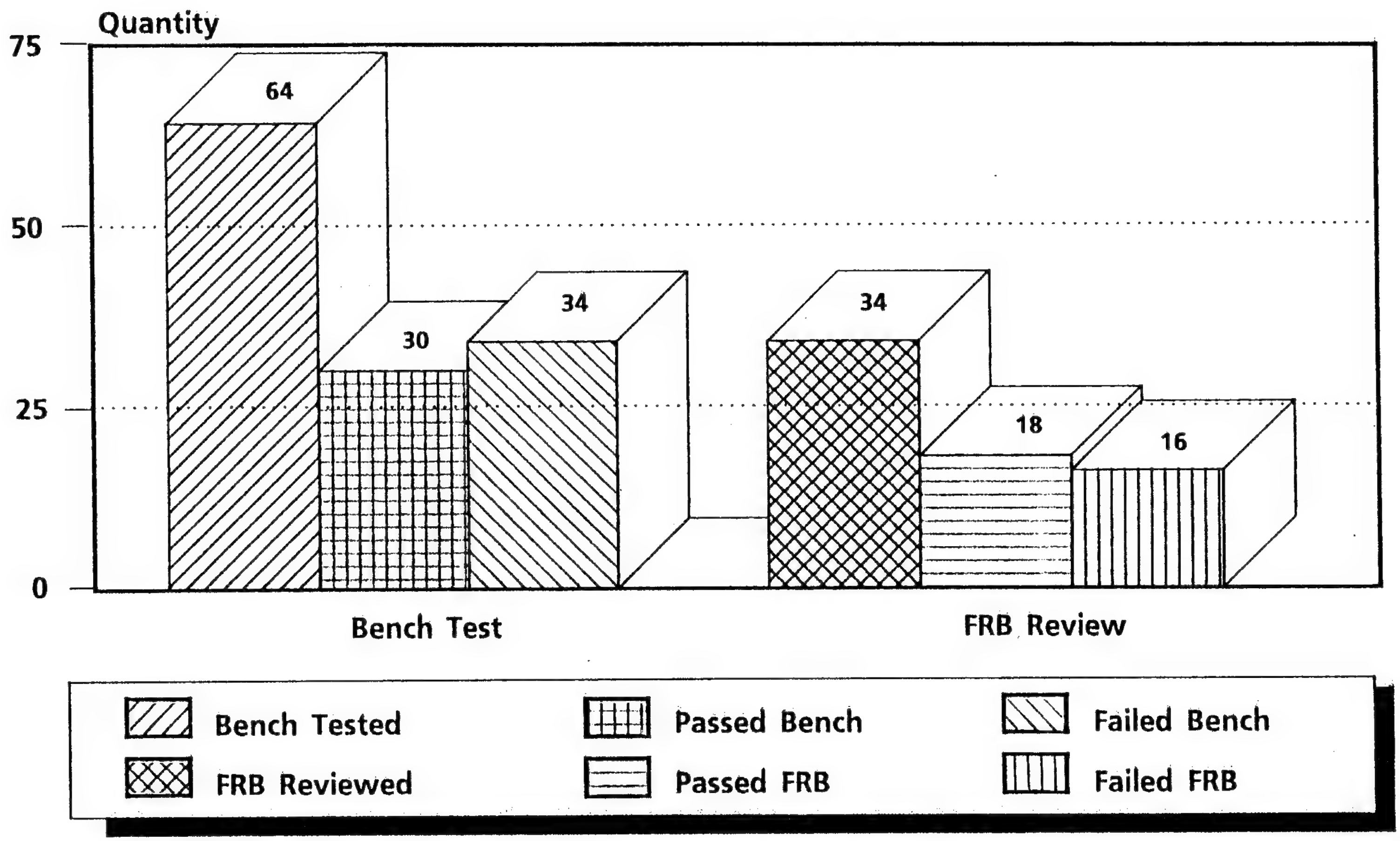
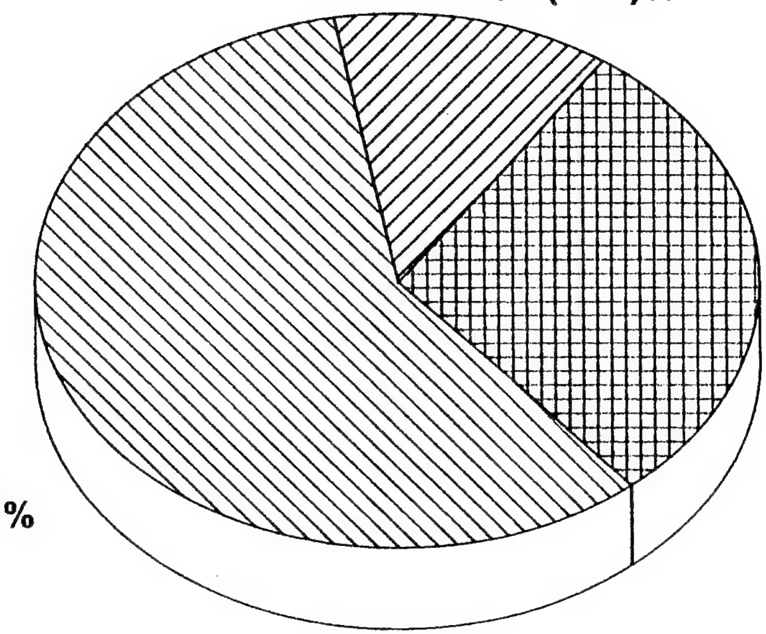


Figure 5.2.2 (c)

AN/ALQ-131 DRIVER TWTs

Program Summary: Total TWTs Screened
(Band 3, 4, and 5)



514 Driver TWTs Screened

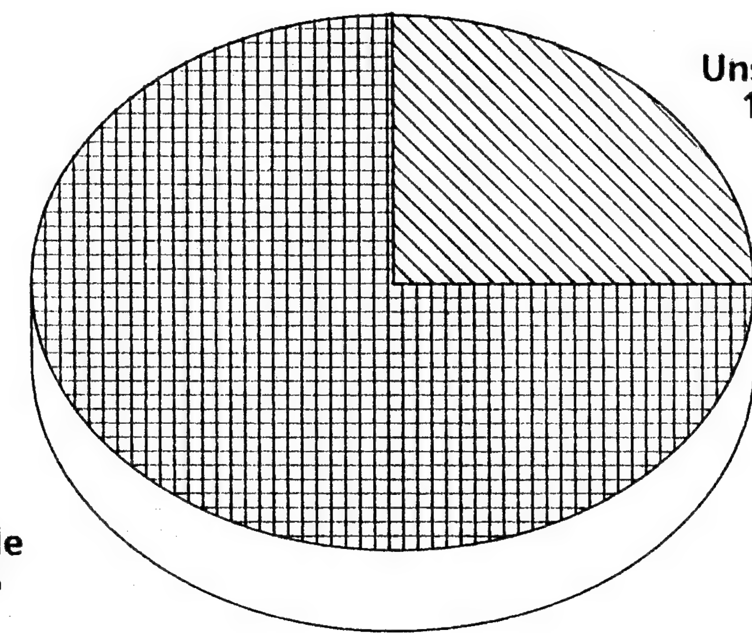
Figure 5.2.3 (a)

5.2.6 Band 5 TWTs (continued)

Band 5 repairable TWTs were also tested on a previous contract initiated by LNXEB. These drivers exhibited the same slow warm-up characteristics as the drivers tested under the current contract. Several of these TWTs were returned to the manufacturer for failure analysis. Litton concluded that the first stage problems were attributed to the cathode diameter. Litton determined that an increase in cathode diameter would improve the performance of the first stage drivers, but with an increase in noise figure. Westinghouse determined that the noise figure specification could not be increased without significant degradation to total system performance.

AN/ALQ-131 DRIVER TWTs

Program Summary: Band 3 Litton (Used)
(Serviceable Versus Unserviceable)



64 Band 3 (Used)
TWTs Screened

Figure 5.2.4 (a)

AN/ALQ-131 DRIVER TWTs

Program Summary: Band 3 Litton (Used)
(Bench Test and FRB Results)

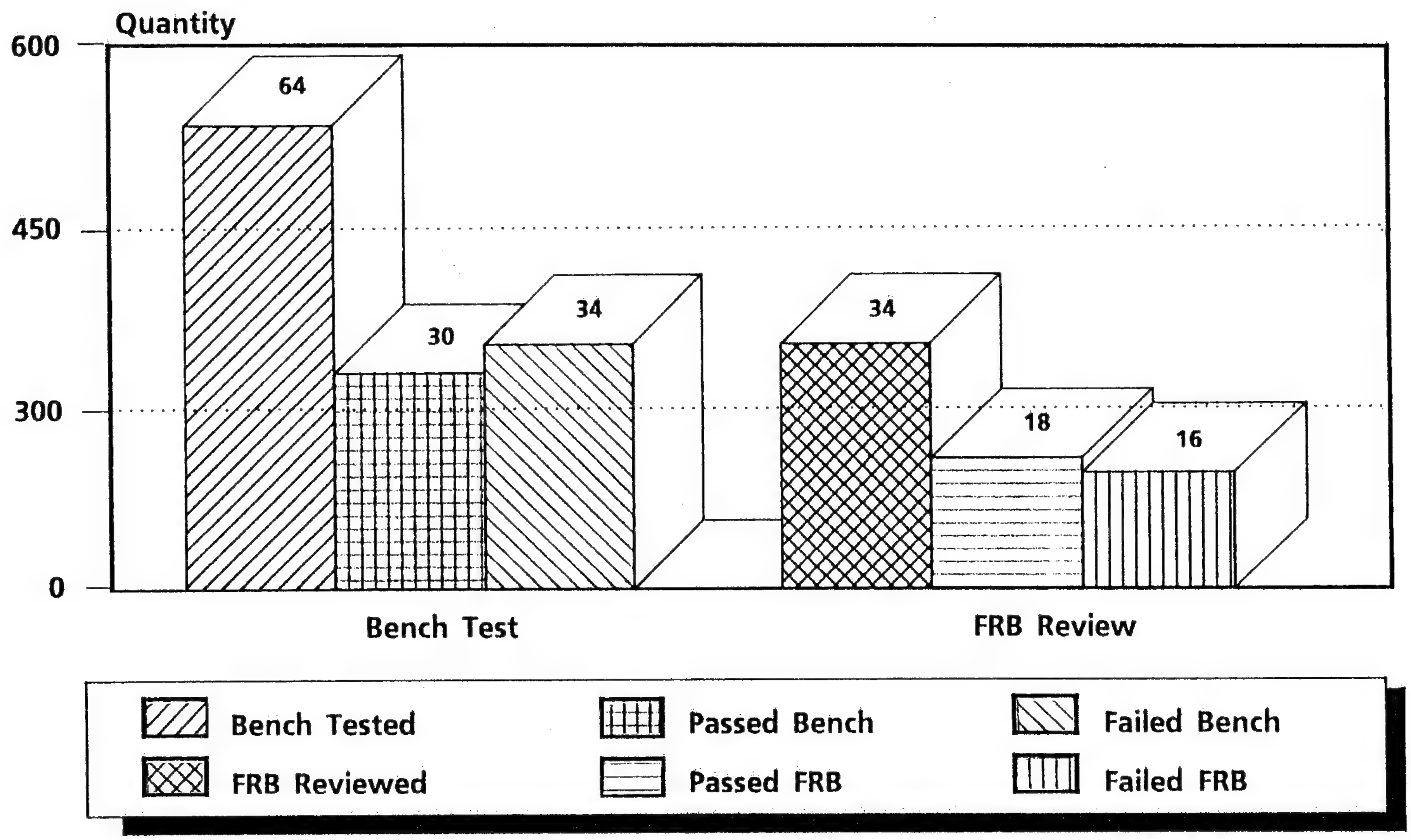
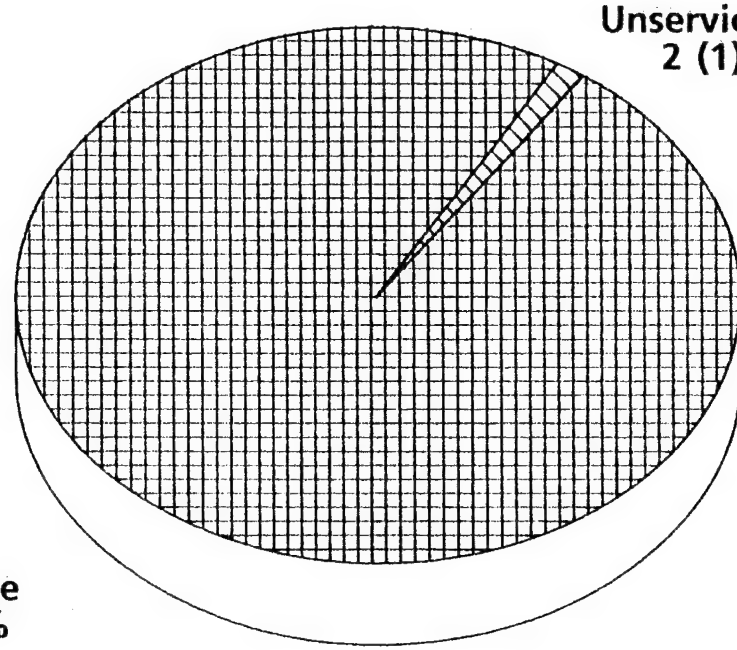


Figure 5.2.4 (b)

AN/ALQ-131 DRIVER TWTs

Program Summary: Band 4 Litton (New)
(Serviceable Versus Unserviceable)



150 Band 4 (New)
TWTs Screened

Figure 5.2.5 (a)

AN/ALQ-131 DRIVER TWTs

Program Summary: Band 4 Litton (New)
(Bench Test and FRB Results)

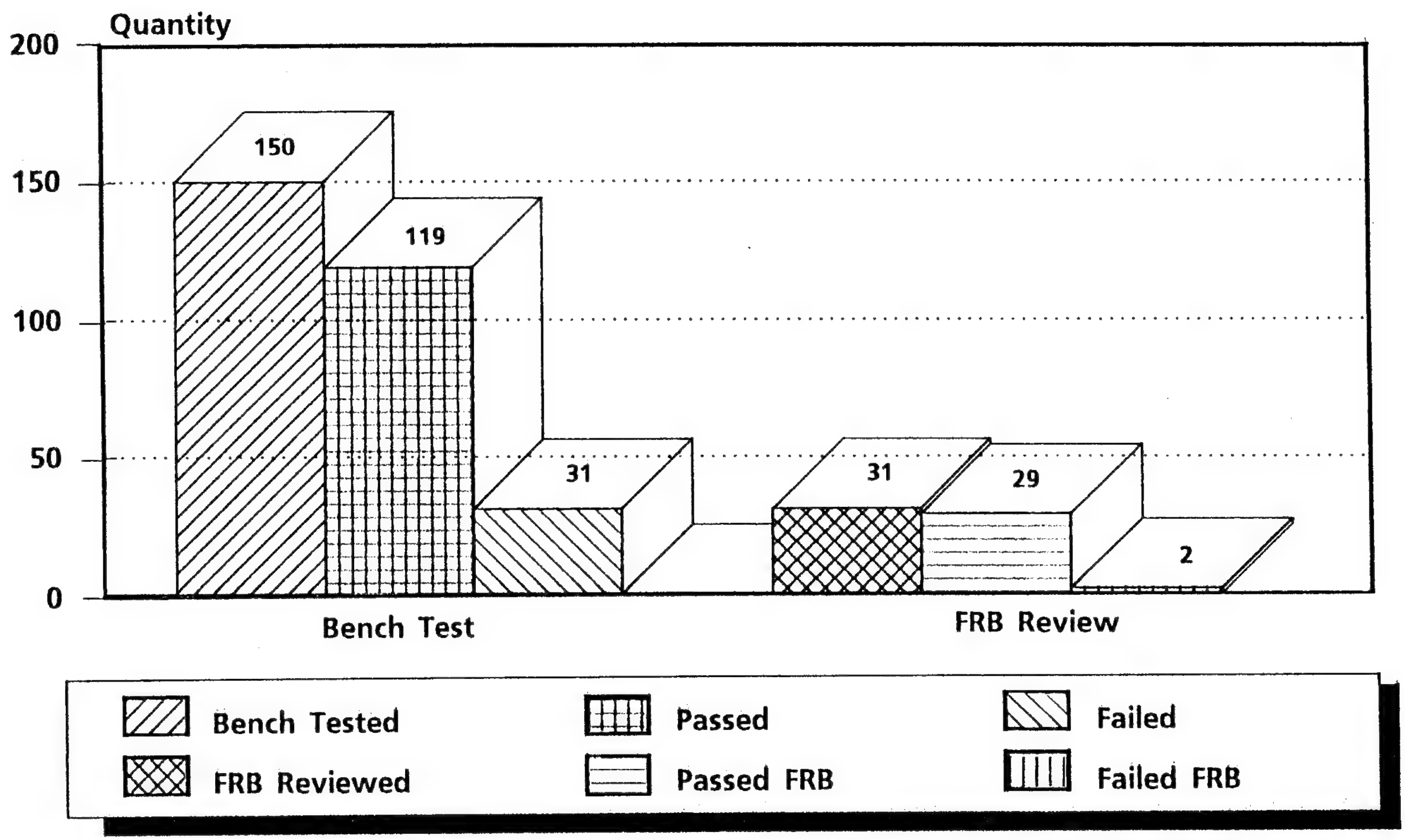
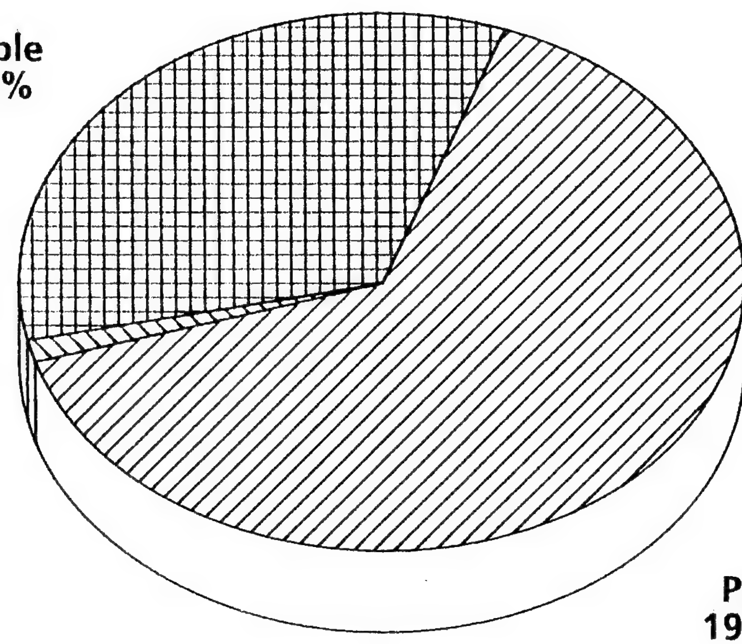


Figure 5.2.5 (b)

AN/ALQ-131 DRIVER TWTs

Program Summary: Band 5 Litton (New)
(Serviceable Versus Unserviceable)



300 Band 5 (New)
TWTs Screened

Figure 5.2.6 (a)

AN/ALQ-131 DRIVER TWTs

Program Summary: Band 5 Litton (New)
(Bench Test and FRB Results)

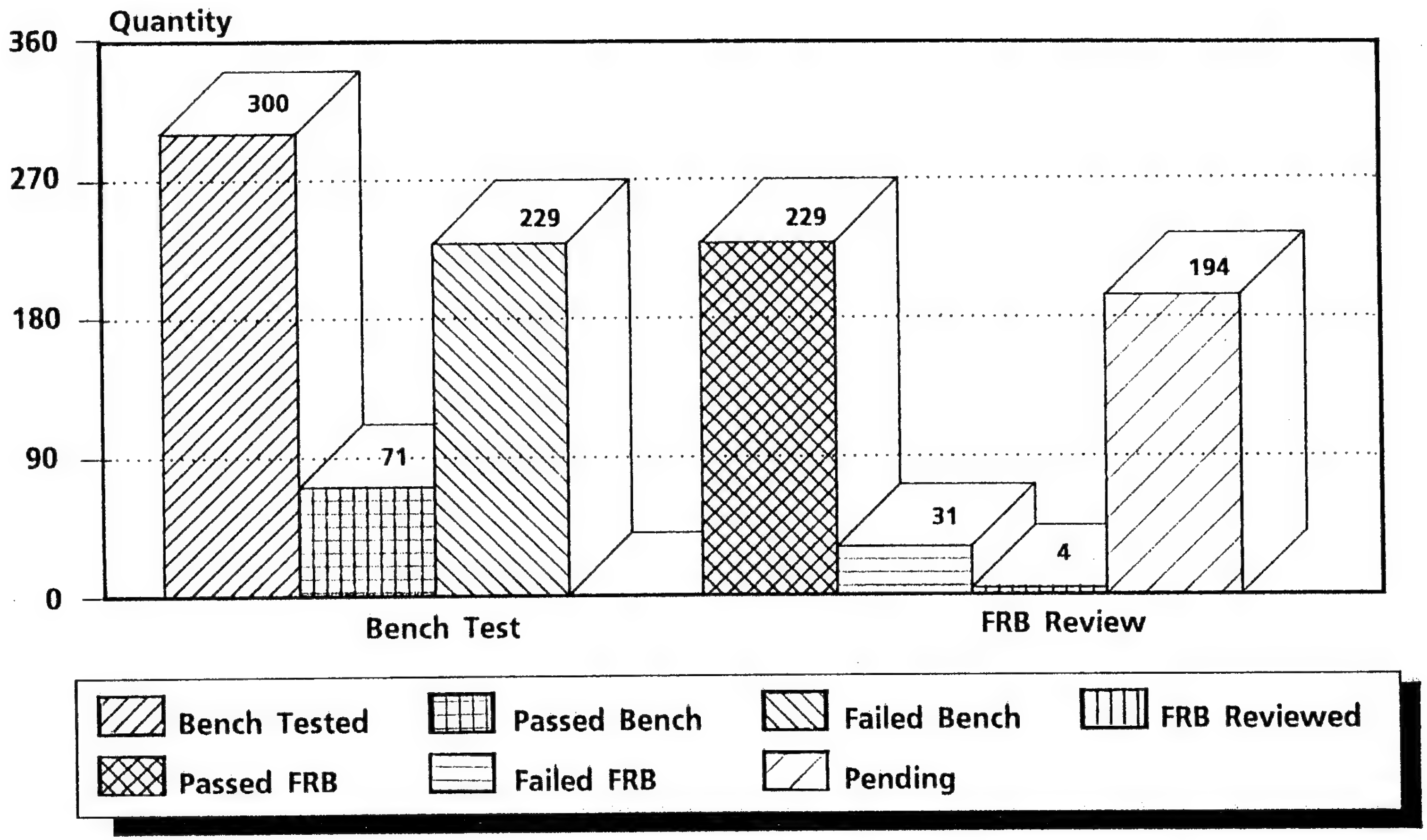


Figure 5.2.6 (b)

6.0 ANALYSIS: OUTPUT TWTS

A data base was established to collect all screening data on each TWT. TWTs that failed ETM screening were assigned failure codes from numbers 1 through 12.

6.1 Failure Codes

To categorize failure data, a series of failure codes were assigned for the most frequent types of failures. The maximum number of failure codes given to each TWT was three. The twelve (12) failure codes used for the output TWT screening are listed below:

6.1.1 Failure Code 1 - Minor Problems

TWTs that exhibited difficulty in turn-on when first put on the ETM, but eventually passed all of the ETM tests. The technician was able to salvage these tubes by using extended burn-in, etc. These tubes would not have turned on if placed directly in the AN/ALQ-131 ECM pod.

6.1.2 Failure Code 2 - Gain

TWTs that failed to meet ATP gain specifications.

6.1.3 Failure Code 3 - Fine Grain (Ripple)

TWTs that failed to meet the fine grain specification.

6.1.4 Failure Code 4 - Power

TWTs that failed to meet ATP power specifications.

6.1.5 Failure Code 5 - Hypot

TWTs that failed to meet insulating and continuity specifications. The hypot test was performed at sea level and at altitude (60,000 feet).

6.1.6 Failure Code 6 - High Helix

TWTs that failed to meet the ATP helix current specification.

6.1.7 Failure Code 7 - Gassy

TWTs that exhibited gassy characteristics during ETM screening.

6.1.8 Failure Code 8 - Grid Leakage

TWTs that failed to meet the ATP grid leakage specification.

6.1.9 Failure Code 9 - Backward Wave Oscillation (BWO)

TWTs that failed to meet the ATP BWO specification.

6.1.10 Failure Code 10 - Mechanical Problems

TWTs that failed to meet the outline drawing specification. Examples of mechanical problems are: lacerated high voltage cable, damaged input connector, damaged output connector, faulty equalizer, and etc.

6.1.11 Failure Code 11 - Perveance (Unstable Gun)

TWTs that exhibited characteristics of an unstable gun.

6.1.12 Failure Code 12 - Possible Re-Optimization

TWTs that could have their operating characteristics improved through minor repair. Examples of minor repairs include replacement of an equalizer, replacement of a voltage specification label, replacement of a thermostat, repair of input connectors, and etc.

6.2 Detailed Test Results

Data was collected on each TWT and entered into a data base during the ETM screening. The data included shipping and receiving information, physical inspection information, TWT operational data, and failure code information. The failure codes were described in paragraph 6.1 and represent the failure symptom monitored during screening. The actual cause of failure can only be determined through failure analysis by the appropriate TWT manufacturer. For this report the discussion will focus on the various failure codes recorded for each TWT. Refer to Appendix A for test summary by serial number.

A summary of the failure code information is depicted in Table 6.2 (a). This information is broken down by vendors and bands. The quantities shown represent the total number of tubes that had a particular failure code. It is important to note that each TWT may have more than one failure code. For example, a TWT may have failed ETM screening for low gain caused by a mechanical problem. Therefore, that TWT would have had failure codes 2 and 10. There was a maximum of three failure codes recorded for each TWT.

A summary of the date code information is depicted in Table 6.2 (b). This information is broken down by vendors and bands. The quantities shown represent the total number of tubes screened with a particular date code. The totals for new and used TWTs are also shown.

		Failure Codes (Total Failures) *											
Vendor	Band	1	2	3	4	5	6	7	8	9	10	11	12
Litton (Used)	3	0	18	0	11	1	6	0	1	0	2	4	6
Varian (Used)	3	0	39	2	10	2	6	5	8	0	5	53	31
Varian (New)	4	12	12	6	0	8	9	7	3	4	9	0	33
Varian (New)	5	0	3	0	7	3	0	0	0	2	1	0	1
TMEC (New)	3	1	3	2	0	0	0	0	0	0	3	0	5
TMEC (New)	4	0	0	0	0	0	0	0	0	1	0	0	0
Subtotal (Used)		0	57	2	21	3	12	5	9	0	7	57	37
Subtotal (New)		13	18	8	7	11	9	7	3	7	13	0	39
Totals		13	75	10	28	14	21	12	12	7	20	57	76

Table 6.2 (a) Output TWT Failure Codes by Vendor

* Each TWT may have more than one failure code

Date Code *															
Vendor	Band	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Missing	Total
Litton (Used)	3	1	2	6	6	0	2	2	5	2	0	0	0	0	26
Varian (Used)	3	0	6	21	9	6	44	8	0	0	0	0	0	24	118
Varian (New)	4	0	0	0	0	19	1	41	96	5	12	100	0	0	274
Varian (New)	5	0	0	0	0	0	0	0	0	0	0	51	19	0	70
TMEC (New)	3	0	0	0	0	0	0	0	0	11	28	0	0	0	39
TMEC (New)	4	0	0	0	0	0	0	0	0	0	0	0	5	0	5
Subtotal (Used)		1	8	27	15	6	46	10	5	2	0	0	0	24	144
Subtotal (New)		0	0	0	0	19	1	41	96	16	40	151	24	0	388
Totals		1	8	27	15	25	47	51	104	18	40	151	24	24	532

Table 6.2 (b) Output TWT Date Codes by Vendor

* Quantity of TWTs tested each year

During the ETM screening process data was also collected indicating which TWTs would have a high probability of being improved, to the extent of passing the ETM tests, by re-optimizing the tube (failure code 12). From the 532 TWTs screened on the ETM, 353 (66%) passed and 179 (34%) failed. There is a high probability that 76 (43%) of the TWTs that failed the ETM screening could have improved operational characteristics by re-optimization [Figure 6.2 (a)].

6.2.1 Program Summary: New Band 3, 4, and 5 TWTs

A total of 389 new TWTs were screened on the ETM. The TWTs consisted of Band 3 TMEC, Band 4 Varian, Band 4 TMEC, and Band 5 Varian (Appendix B, page B-1).

A total of 39 Band 3 TMEC TWTs were screened. Thirty-five (90%) of the 39 TWTs were returned to WR-ALC as serviceable, and 4 (10%) were returned as unserviceable.

A total of 274 Band 4 Varian TWTs were screened. Two hundred thirty-nine (87%) of the 274 TWTs were returned to WR-ALC as serviceable, and 35 (13%) were returned as unserviceable.

A total of 5 Band 4 Block II TMEC TWTs were screened. All 5 (100%) of the TWTs were returned to WR-ALC as serviceable.

A total of 70 Band 5 Varian TWTs were screened. Sixty-five (93%) of the 70 TWTs were returned to WR-ALC as serviceable, and 5 (7%) were returned as unserviceable.

6.2.2 Program Summary: Used Band 3 TWTs

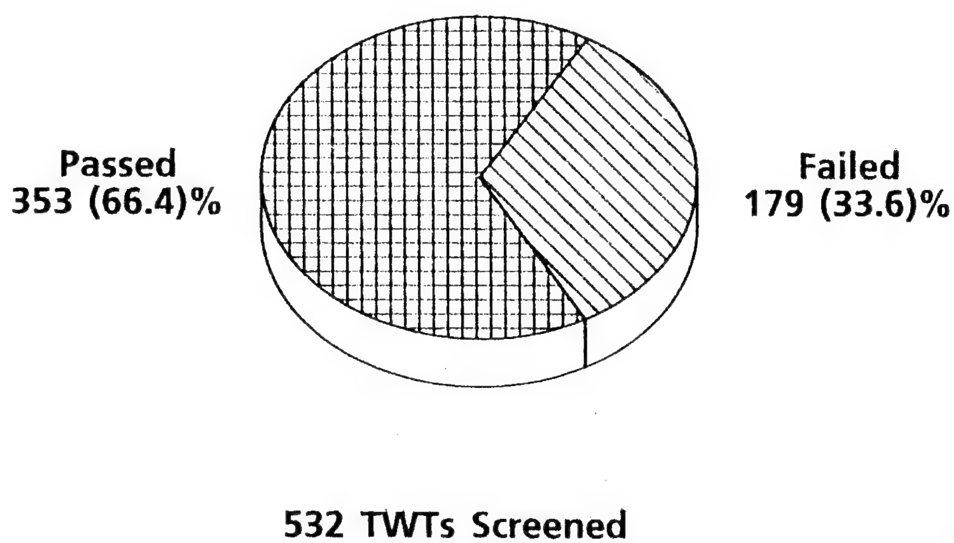
A total of 144 used Band 3 TWTs were screened on the ETM. They consisted of Litton and Varian TWTs (Appendix B, page B-2).

A total of 26 Band 3 Litton TWTs were screened. Four (15%) of the 26 TWTs were returned to WR-ALC as serviceable, and 22 (85%) were returned as unserviceable.

A total of 118 Band 3 Varian TWTs were screened. Sixty-one (52%) of the 118 TWTs were returned to WR-ALC as serviceable, and 57 (48%) were returned as unserviceable.

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Output TWTs Re-optimization



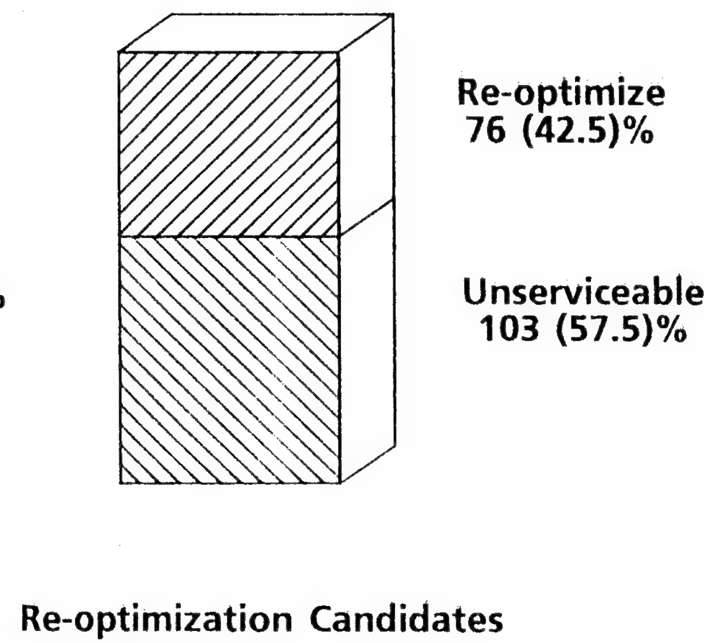


Figure 6.2 (a)

6.2.3 Screening Summary: New Versus Used TWTs

A total of 388 new TWTs and 144 used TWTs were screened on the ETM (Appendix B, page B-3). Three hundred sixteen (81%) of the new TWTs passed the ETM screening, and 72 (19%) failed. Thirty-seven (26%) of the used TWTs passed the ETM screening and 107 (74%) failed.

6.2.4 Screening Summary: New Versus Used TWTs by Failure Code

There is a noticeable difference in the distribution of failure codes between new and used TWTs (Appendix B, page B-4).

The new TWTs had higher failures in (1) minor problems, failure code 1, (2) fine grain, failure code 3, (3) Hypot, failure code 5, (4) gassy, failure code 7, (5) BWO, failure code 9, (6) mechanical, failure code 10, and (7) re-optimization, failure code 12.

The used TWTs had higher failures in (1) gain, failure code 2, (2) power, failure code 4, (3) helix, failure code 6, (4) grid leakage failure code 8, and (5) perveance, failure code 11.

Minor problems, failure code 1, was only exhibited in the new TWTs. There was a total of 13 TWTs that would have failed if they would have been installed in an AN/ALQ-131 ECM pod. Due to the capabilities of the ETM, it was possible for these TWTs to be turned on at a lower duty cycle and over time be brought up to normal operating specifications. All of these TWTs passed the ETM tests and were returned to WR-ALC as serviceable.

Perveance, failure code 11, was a major problem with the used TWTs. A total of 57 TWTs exhibited this problem. Refer to paragraph 8.2 for a detailed analysis of this problem.

Re-optimization, failure code 12, was used to identify the TWTs that failed the ETM screening, but could be improved through re-optimization or minor repair so that they would pass the ETM screening. There is a total of 39 new TWTs and 37 used TWTs that would pass the ETM tests if re-optimized or had minor repair performed. Minor repairs can be performed at the Warner Robins Regional Service Center. Examples of minor repairs are (1) changing equalizers and (2) changing hardlines. Re-optimizing is locating the optimal operating parameters of the TWT utilizing the ETM and then installing a new parameter label on the TWT.

It was not in the scope of this contract to analyze all of the failure modes of the TWTs. This would be appropriate in the future when part of the TWTs can be returned to the manufacturer for failure analysis.

6.2.5 Screening Summary: Band 3, 4, and 5 Failure Rate Over Time by Failure Code

The graphs in Appendix B, pages B-5 through B-16 depict the failure rate over time for each of the twelve failure codes. The data codes of the TWTs screened range from 1979 through 1990. Also, 34 used TWTs did not have a date code.

6.2.6 Screening Summary: Band 3 TWTs by Vendors

A total of 183 Band 3 TWTs were screened on the ETM which consisted of both new and used TWTs. The breakdown was 118 (64%) used Varian TWTs, 26 (14%) used Litton TWTs, and 30 (21%) new TMEC TWTs (Appendix B, page B-17).

6.2.7 Screening Summary: Band 3 Overall Failure Rate Over Time by Failure Code

The graphs in Appendix B, pages B-18 through B-28 depict the failure rate over time for eleven of the twelve failure codes. There were not any Band 3 TWTs that failed for BWO, failure code 9. The date codes range from 1979 through 1988. Also, 34 used TWTs did not have a date code.

6.2.8 Screening Summary: Band 3 TMEC (New)

A total of 39 TMEC TWTs were screened on the ETM. Thirty-four (87%) of the 39 TWTs passed the ETM screening and 5 (13%) failed (Appendix B, page B-29).

6.2.9 Screening Summary: Band 3 TMEC (New) Failure Rate Over Time by Failure Code

The graphs in Appendix B, pages B-30 through B-34 depict the failure rate over time for five of the twelve failure codes. There were not any Band 3 TMEC TWTs that failed for failure codes 4, 5, 6, 7, 8, 9, or 11. The date codes range from 1987 through 1988. There are not any noticeable trends in the failure rates since the date code of the tubes over covers a span of two years.

6.2.10 Screening Summary: Band 3 TMEC (New) Failure Code Distribution by Date Code

The graphs in Appendix B, pages B-35 and B-36 depict the failure code distribution over time for the Band 3 TMEC TWTs. The date code distribution charts show no noticeable trends since the sample size of tubes is small.

6.2.11 Screening Summary: Band 3 TMEC (New) by Failure Code

One TWT failed for minor problems, failure code 1. This TWT would have failed if installed in the AN/ALQ-131 ECM pod. Once the TWT was burned-in utilizing a lower duty cycle, it passed the ETM tests (Appendix B, page B-37).

Five (5) of the 39 Band 3 TMEC TWTs screened failed the initial ETM tests. All 5 tubes have a high probability of passing the ETM test after re-optimization or minor repair, failure code 12. There are not any other noticeable trend in the failure code information.

6.2.12 Screening Summary: Band 3 (Used)

A total of 144 Band 3 (Used) TWTs were screened on the ETM. Thirty-seven (26%) of the 144 TWTs passed the ETM screening and 107 (74%) failed (Appendix B, page B-38).

6.2.13 Screening Summary: Band 3 (Used) Failure Rate Over Time by Failure Code

The graphs in Appendix B, pages B-39 through B-48 depict the failure rate over time for ten of the twelve failure codes. Not any Band 3 (Used) TWTs failed for minor problems, failure code 1, or BWO, failure code 9. The date codes range from 1979 through 1987. Also, 34 used TWTs did not have a date code.

A high percentage of the TWTs exhibited problems with gain, failure code 2, throughout the date code range (Appendix B, page B-39). The most likely cause of this is related to the high percentage of TWT failures caused by perveance problems, failure code 11 (Appendix B, page B-47). Refer to paragraph 8.2 for detailed analysis of the perveance problem.

A consistently high percentage of the TWTs can be improved by re-optimization, failure code 12, over time (Appendix B, page B-48).

6.2.14 Screening Summary: Band 3 (Used) by Failure Code

The graph in Appendix B, page B-49 also shows a high quantity of failures for gain, failure code 2, and perveance, failure code 11, as stated in paragraph 6.2.13. A total of 37 TWTs have a high probably of passing the ETM tests after being re-optimized, failure code 12.

The other failure codes are distributed throughout the failure code range. There are no other visible trends in this data.

6.2.15 Screening Summary: Band 3 Varian (Used)

A total of 118 Band 3 Varian (Used) TWTs screened on the ETM. Thirty-six (31%) of the 118 TWTs passed the ETM screening and 82 (69%) failed (Appendix B, page B-50).

6.2.16 Screening Summary: Band 3 Varian (Used) Failure Rate Over Time by Failure Code

The graphs in Appendix B, pages B-51 through B-60 depict the failure rate over time for ten of the twelve failure codes. No Band 3 Varian TWTs failed for failure codes 1 and 9. The date codes range from 1980 through 1985. Also, 34 Varian TWTs did not have a date code.

Gain, failure code 2, consistently had a high failure rate throughout the date code range (Appendix B, page B-51). A possible cause for this is that perveance, failure code 11, also had a consistently high failure rate over the years (Appendix B, page B-59). There is a high probability that these TWTs would pass the ETM tests if they were re-optimized or had minor repair, failure code 12, performed on them (Appendix B, page B-60).

6.2.17 Screening Summary: Band 3 Varian (Used) Failure Code Distribution by Date Code

The graphs in Appendix B, pages B-61 through B-67 depict the failure code distribution over time for the Band 3 Varian TWTs. These graphs also show the perveance problem, failure code 11, throughout the date code range. They also depict the quantity of TWTs that have a high probability of being recovered if re-optimization was done.

6.2.18 Screening Summary: Band 3 Varian (Used) by Failure Code

The failures were distributed throughout the majority of the failure codes. The highest failures occurred in gain, failure code 2, and perveance, failure code 11 (Appendix B, page B-68). This is the same result that was showed in the previous graphs. Thirty-one Band 3 Varian TWTs have a high probability of passing the ETM tests if they are re-optimized, failure code 12, or had minor repair performed. The remaining failures were evenly distributed throughout the remaining failure codes.

6.2.19 Screening Summary: Band 3 Litton (Used)

A total of 26 Band 3 Litton TWTs were screened on the ETM. One (4%) of the 26 TWTs passed the ETM screening, and 25 (96%) failed (Appendix B, page B-69).

6.2.20 Screening Summary: Band 3 Litton (Used) Failure Rate Over Time by Failure Code

The graphs in Appendix B, pages B-70 through B-77 depict the failure rate over time for eight of the twelve failure codes. There were not any Band 3 Litton TWTs that failed for failure codes 1, 3, 7, or 9. The date codes range from 1979 through 1987. Failure code 2, gain, consistently has a high failure rate throughout the date code range. Failure code 4, power, also has a high failure code over the date code range. This problem does not appear to be attributed to a perveance problem as in the Band 3 Varian (Used) TWTs.

6.2.21 Screening Summary: Band 3 Litton (Used) Failure Code Distribution by Date Code

The graphs in Appendix B, pages B-78 through B-85 depict the failure code distribution over time for the Band 3 Litton TWTs. Failure codes 2, gain, and 4, power, are among the highest failures for each of the date codes which range from 1979 through 1987. There is also a high probability of successfully re-optimizing 6 of the TWTs that failed the ETM screening.

6.2.22 Screening Summary: Band 3 Litton (Used) by Failure Code

A total of 18 TWTs failed for gain, failure code 1, and 11 TWTs failed for power, failure code 4 (Appendix B, page B-86). This was also noticeable in the previous graphs.

The Band 3 Litton TWTs also exhibited failures for perveance, failure code 11, but not to the extent that the Band 3 Varian TWTs did. This probably contributed to the higher quantity of failures in gain and power.

This graph also shows the 6 TWTs that have a high probability of being successfully re-optimized.

6.2.23 Screening Summary: Band 4 (New) by Vendors

A total of 280 Band 4 TWTs were screened. A total of 275 (98%) Varian Block I TWTs and 5 TMEC (2%) Block II TWTs were screened on the ETM (Appendix B, page B-87). Varian had the single highest quantity of output TWTs screened during this program.

6.2.24 Screening Summary: Band 4 (New) Failure Rate Over Time by Failure Code

The graphs in Appendix B, pages B-88 through B-97 depict the failure rate over time for ten of the twelve failure codes. No Band 4 (New) TWTs failed for power, failure code 4, or perveance, failure code 11. There were no significant failure trends through the failure code range.

6.2.25 Screening Summary: Band 4 TMEC (New)

A total of 5 Band 4 TMEC Block II TWTs were screened on the ETM. Four (80%) of the 5 TWTs passed the ETM screening and 1 (20%) failed (Appendix B, page B-98). The TMEC representatives discovered that the failed TWT had an incorrectly sized o-ring which was replaced and retested on the ETM. The TWT passed all of the ETM tests, and was returned as serviceable.

6.2.26 Screening Summary: Band 4 TMEC (New) Failure Rate Over Time by Failure Code

There are no trends in this data since there was only a single failure, and all of the Band 4 TMEC TWTs screened had the same date code (Appendix B, page B-99).

6.2.27 Screening Summary: Band 4 TMEC (New) Failure Code Distribution by Date Code

There are no trends in this data since there was only a single failure for the Band 4 TMEC TWTs screened (Appendix B, page B-100).

6.2.28 Screening Summary: Band 4 TMEC (New) by Failure Code

There are no trends in this data since there was only a single failure for the Band 4 TMEC TWTs screened (Appendix B, page B-101).

6.2.29 Screening Summary: Band 4 Varian (New)

A total of 274 Band 4 Varian TWTs screened on the ETM. Two hundred twenty- two (81%) of the 274 TWTs passed the ETM screening, and 52 (19%) failed (Appendix B, page B-102). This was the largest single sample of output TWTs screened during this contract.

6.2.30 Screening Summary: Band 4 Varian (New) Failure Rate Over Time by Failure Code

The graphs in Appendix B, pages B-103 through B-112 depict the failure rate over time for ten of the twelve failure codes. There were no Band 4 TWTs that failed for power, failure code 4, or perveance, failure code 11. The date codes ranged from 1983 through 1989.

A consistent amount of TWTs exhibited minor problems, failure code 1, throughout the date code range (Appendix B, page B-103). These were TWTs that would have failed if placed inside an AN/ALQ-131 ECM pod. Due to the capabilities of the ETM, the technician was able to bring up the TWT slowly at a lower duty cycle until it would pass all of the ETM tests. A high percentage of the TWTs screened have a high probability of being re-optimized, failure code 12, (Appendix B, page B-112). This percentage is exhibited throughout the date code range.

6.2.31 Screening Summary: Band 4 Varian (New) Failure Code Distribution by Date Code

The graphs in Appendix B, pages B-113 through B-117 depict the failure code distribution over time for the Band 4 Varian TWTs. These graphs also show the quantity of TWTs with failure codes 1, minor problems, and 12, re-optimization candidates. It also appears that all of the failures are distributed throughout the failure code range over time.

6.2.32 Screening Summary: Band 4 Varian (New) by Failure Code

The graph in Appendix B, page B-118 shows the quantity of failures for each of the twelve failure codes. Failure code 1, minor problems, occurred in 12 (23%) of the 52 failures. Failure code 2, gain, also occurred in 12 (23%) of the failures. The graph shows that there is a quantity of 33 (63%) of the TWTs that failed ETM screening that have a high probability of passing the ETM tests if they are re-optimized, failure code 12.

6.2.33 Screening Summary: Band 5 Varian (New)

A total of 70 Band 5 Varian TWTs screened on the ETM. Fifty-six (80%) of the 70 TWTs passed the ETM screening and 14 (20%) failed (Appendix B, page B-119).

6.2.34 Screening Summary: Band 5 Varian (New) Failure Rate Over Time by Failure Code

The graphs in Appendix B, pages B-120 through B-125 depict the failure rate over time for six of the twelve failure codes. There were no Band 5 (New) TWTs that failed for failure codes 1, 3, 6, 7, 8, and 11. The date codes range from 1989 through 1990. It is difficult to see any trends in these graphs since the date code range is so short (two years).

6.2.35 Screening Summary: Band 5 Varian (New) Failure Code Distribution by Date Code

The graphs in Appendix B, pages B-126 and B-127 depict the failure code distribution over time for the Band 5 Varian TWTs. These graphs show that that the largest failure over the two years is power failure code 4. Seven (50%) of the 14 TWTs that failed exhibited this problem. The remaining failures are distributed throughout the failure code range.

6.2.36 Screening Summary: Band 5 Varian (New) by Failure Code

The major problems with the Band 5 Varian TWTs are gain (failure code 2), power (failure code 4), and hypot (failure code 6). The remaining failures were distributed through three different failure codes (Appendix B, page B-128).

6.3 Statistical Analysis

6.3.1 Band 3 TMEC TWTs

The tubes tested in this contract were identified not only by the band, vendor, type (output or driver), and as new or used, but also by its manufacture date code. The span of time from the tube's date code to the date when it was tested is called here the shelf life of the tube. This shelf life is unambiguous only for the new tubes, therefore the analysis in this parameter will be limited to the new tubes.

The lowest resolution in shelf life is one week due to the above mentioned date code. For each category of tubes Tables 6.3.1 (a), 6.3.2 (a), 6.3.4 (a), and 6.3.5 (a) represent the test results in tabular form consisting of four rows and as many columns as the shelf life of tubes, expressed in weeks, require. Thus in Table 6.3.1 (a), the test and screening results are shown for the TMEC, band 3 tubes. There was only one tube with the shelf life of 83 weeks. This tube passed the ETM test; because of this it was never screened by the FRB. Therefore, the number of failures, both for ETM and for FRB, is zero. As another example consider the sample of tubes with the shelf life of 107 weeks. There were 3 of them, one failed the ETM test. It was screened by the FRB and it passed the screening, hence the ETM entry is marked 1 and the FRB entry is marked 0. The tabular data, as in Table 6.3.1 (a), is basic and fundamental, but it is not in a form that is readily understood intuitively. The same data can be presented in graphic form. There are many ways to plot the statistical results. For example, one can plot the cumulative distribution, the density distribution, or various modifications of these. For our purpose the most convenient statistic is the fraction of items that fail per unit time, or the failure rate. Thus let "n" represent the number of items at the time "t", and let F(t) be the fraction of items that fail at "t", then the statistic of interest is

$$\frac{1}{n_s}\frac{dn_f}{dt} = \frac{F'(t)}{1-F(t)} = \lambda(t)$$

where $n_f = nF$ is the number of the failed items

$\frac{dn_f}{dt} = nF'$ is the rate at which failed items change

$n_s = n(1-F)$ is the number of surviving items

Reference G. H. Sandler, System Reliability Engineering Prentice-Hall, Inc. 1963, p. 68.

This statistic is much more sensitive to the nature of distribution than either the cumulative or the density functions. Moreover, it has a very solid reference point. When the failure function F(t) is exponential ($1-e^{-\lambda t}$), the failure rate is a constant. If we plot the data in the above manner, it will be possible to see if there is a constant component and what the deviations are from the constant case. Should the failure function F(t) deviate significantly from the exponential case that also would be easily recognized from the plots based on the above statistic.

One should note that the data in the Tables are already presented in the form that is convenient for plotting the failure rate. All one has to do is to plot the ratio of the entry under either FRB or ETM, whichever is being considered, to the sample size N on the ordinate at the indicated age (shelf life). This has been done for the TMEC, band 3 category shown in Figure 6.3.1 (a). Altogether there were 39 tubes tested with five ETM failures and four FRB failures. The graph shows the gaps in the data which most likely correspond to time intervals between production releases. This implies that for any specific category of TWTs the samples are not going to be uniformly spread over time, but will come in spurts of production lot releases.

The second observation is that this type of plot produces the jaggedy behavior of the "curve" from which trends are difficult to infer.

The third observation is that the points entered in the plot are not of equal weight. For example, at 104 weeks the fraction of 0/6, a second point on the plot, has a weight six times higher than the next point of 1/1 at 106 weeks for the simple reason that the first is based on the sample size of 6 (N=6) compared to the sample size of one (N=1).

Table 6.3.1 (a) TMEC Band 3 Output TWTs Test Results Versus Shelf Life in Weeks

FRB	0	0	0	1	0	0	0	1	0	0	0	1
ETM	0	0	0	1	0	1	0	1	0	0	0	1
N	1	4	2	1	2	1	4	1	2	2	1	4
Wks	83	104	104	106	107	107	108	108	109	111	113	114
Av. Wks	99.8		105.6			107.8		109.6			113.8	

FRB	0	0	0	0	0	0	0	0	0	0	1	0
ETM	0	0	0	0	0	0	0	0	0	0	1	0
N	2	1	1	1	1	1	1	1	1	1	2	1
Wks	124	127	129	144	144	147	148	149	152	152	154	156
Av. Wks	129.6				148					153.8		

Legend:
Wks = Shelf Life in Weeks of the Tubes Tested or Screened
N = Sample Size for the Indicated Shelf Life
ETM = The Number of Tubes in Sample N that Failed the ETM Test
FRB = The Number of Tubes that Failed the FRB Screening
Av. Wks = The Average Shelf Life in Weeks per Group

AN/ALQ-131 OUTPUT TWTs

TMEC Band 3 Output TWTs ETM Test Results

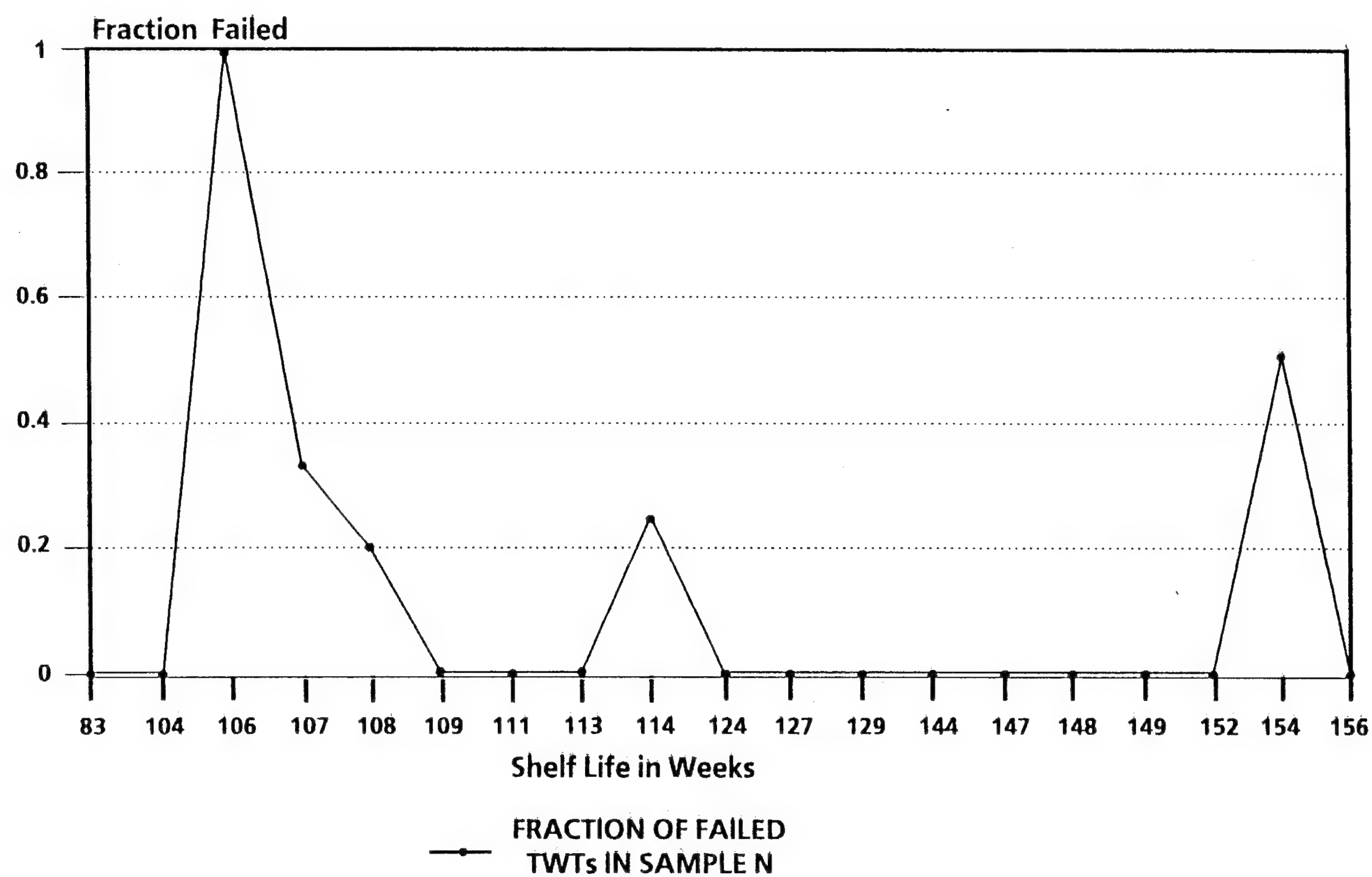


Figure 6.3.1 (a)

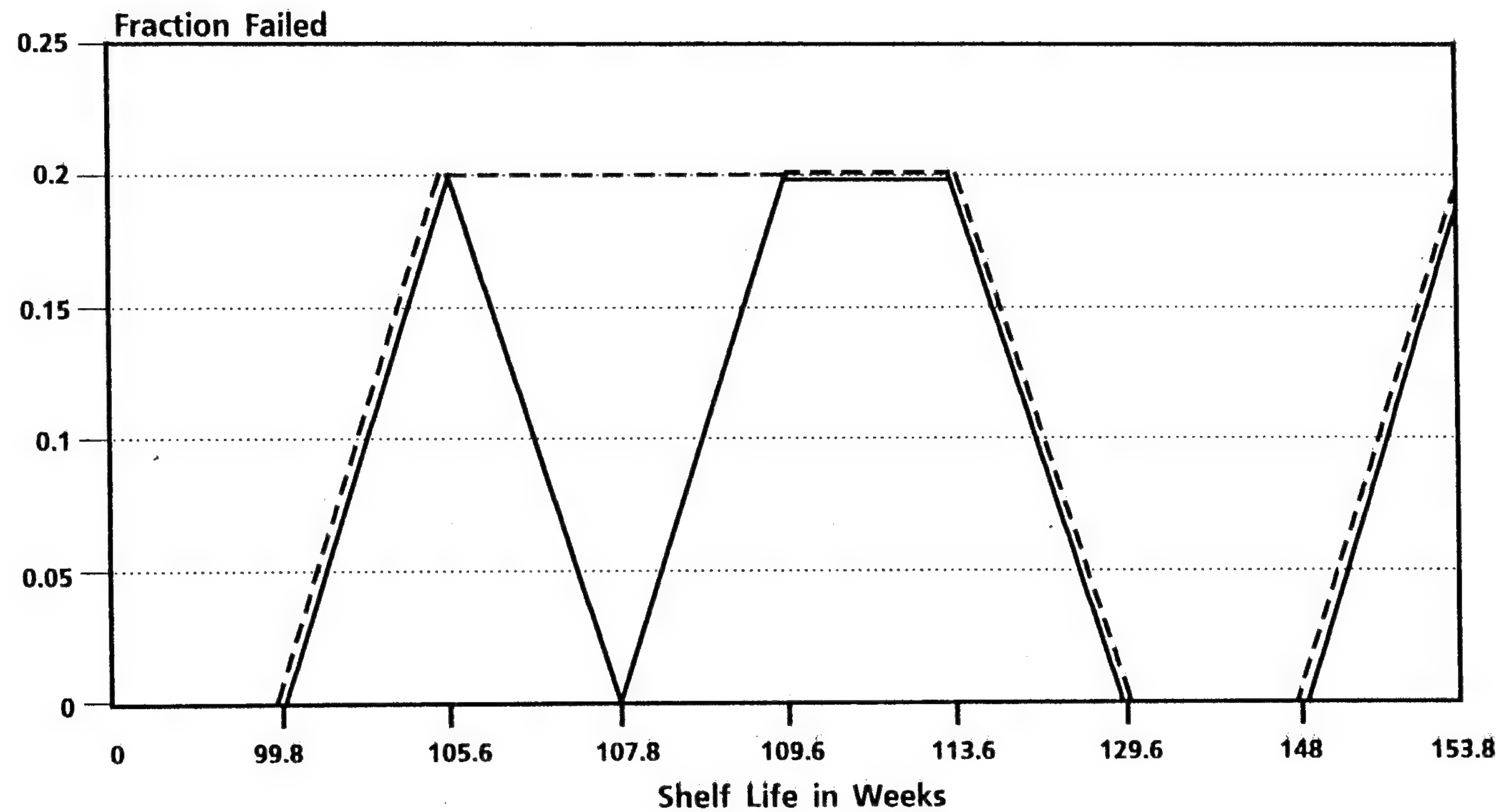
In order to detect the trend in the data, to smooth out the jaggedness of the "curve", and to make all points of equal weight, it was decided to partition the basic tabular data into groups of a higher sample number such as 5, 10, or 20 depending on the number of TWTs tested. These groups are indicated in the tabular data by the vertical bars. Here, one should note that sometimes it is necessary to split a sample of a given age to two adjoining groups with the assignment of the failures to either group being completely arbitrary. In our data the failure allocations were made so as to minimize oscillations or excursions in the curve. When the data is plotted by groups, the smoothing and equalization of weights is achieved at the expense of the shelf life resolution. The group, as an entity, does not possess a unique age, but has as many ages as there are members in it. The best that one can do is to assign an average age to the group by adding all ages and dividing the sum by the number of samples (N).

The TMEC band 3 TWT test results were partitioned into eight groups of 5 each, the last one containing four samples only, for a total of 39. In Figure 6.3.1 (b) each group is plotted as a single point at its average age, the ordinate representing the fraction of failed tubes in a group of five (and four for the last group).

The jaggedness has been suppressed, and if the data contained a trend, it would be readily visible. Ignoring the one missing sample in the last group, all points in the graph enjoy an equal statistical weight. However, eight points is not an adequate number to define a distribution; moreover, they are bunched in a short interval with big gaps at other coordinate values. The problem is that the five ETM failures or four FRB failures is not nearly enough even to suggest the behavior of the curve or to draw any conclusions from it. But they will be used together with other categories for a composite case.

AN/ALQ-131 OUTPUT TWTs

TMEC Band 3 Output TWTs ETM/FRB Failures



Each point represents a fraction of failed TWTs in a sample of 5 (the last point is based on a sample of 4)

Figure 6.3.1 (b)

6.3.2 Band 4 Varian TWTs

The next category in the new output tubes is the Varian band 4 TWTs. The basic data for this category is shown in Table 6.3.2 (a). In this case there are too many points (275) to plot them individually at the resolution of one week. Instead the resolution was relaxed to three months (a quarter on the yearly scale) in order to make the plot manageable. The result is shown in Figure 6.3.2 (a).

One notes immediately that the data covers three finite time intervals that most likely correspond to the production releases for this type of tube. This fact not only makes the data discontinuous, but also makes one hesitant to assume that the production conditions from lot to lot were identical or even similar. Although some smoothing has been achieved by going to a wider time base, significant excursions still persist. Also, the points are of varying statistical weight as is indicated by the numerical fractions written above the graph.

Again to smooth out the excursions and to equalize the weights, the basic data was partitioned into groups of twenty samples with the last group containing only fifteen. The group data was plotted at each group's average age with the results shown in Figure 6.3.2 (b). It is clear that the oscillations were toned down to a large extent and a trend in the data is more discernable.

A casual glance at the data gives impression of an increasing curve with an almost constant, positive slope. To facilitate the interpretation of the curve, let us ignore the first and the last point on the graph. Next, take points 3 and 4 and replace them with their average value; do the same to points 5 and 6 and the last pair of points (12 and 13).

Having done this the curve turns into two straight lines, one at .15 and the other at .25 level with a discontinuity occurring in the last quarter of the fourth year.

Table 6.3.2 (a) Varian Band 4 Output TWTs Test Results Versus Shelf Life in Weeks

FRB	1	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
ETM	1	0	1	0	1	1	0	1	0	0	0	1	0	0	0	1	0	0	0	4	3	0	0	0	1	0
N	4	2	4	10	4	2	1	6	1	4	2	10	1	1	1	4	3	5	5	10	3	3	1	3	7	3
Wks	4	9	11	13	13	15	17	19	23	24	28	28	29	33	35	37	42	42	46	50	50	54	55	56	58	60
Av. Wks	10.4				19.4							32.55						47.0			56.05					

FRB	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
ETM	0	2	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	1	0	1	0	0	0	2
N	7	5	1	2	1	1	3	2	3	1	1	5	4	1	3	3	1	4	1	1	1	3	1	5
Wks	60	63	158	159	160	162	166	166	172	174	175	176	177	180	181	182	184	185	186	187	188	189	190	192
Av. Wks	101.55							175.4								187.4								

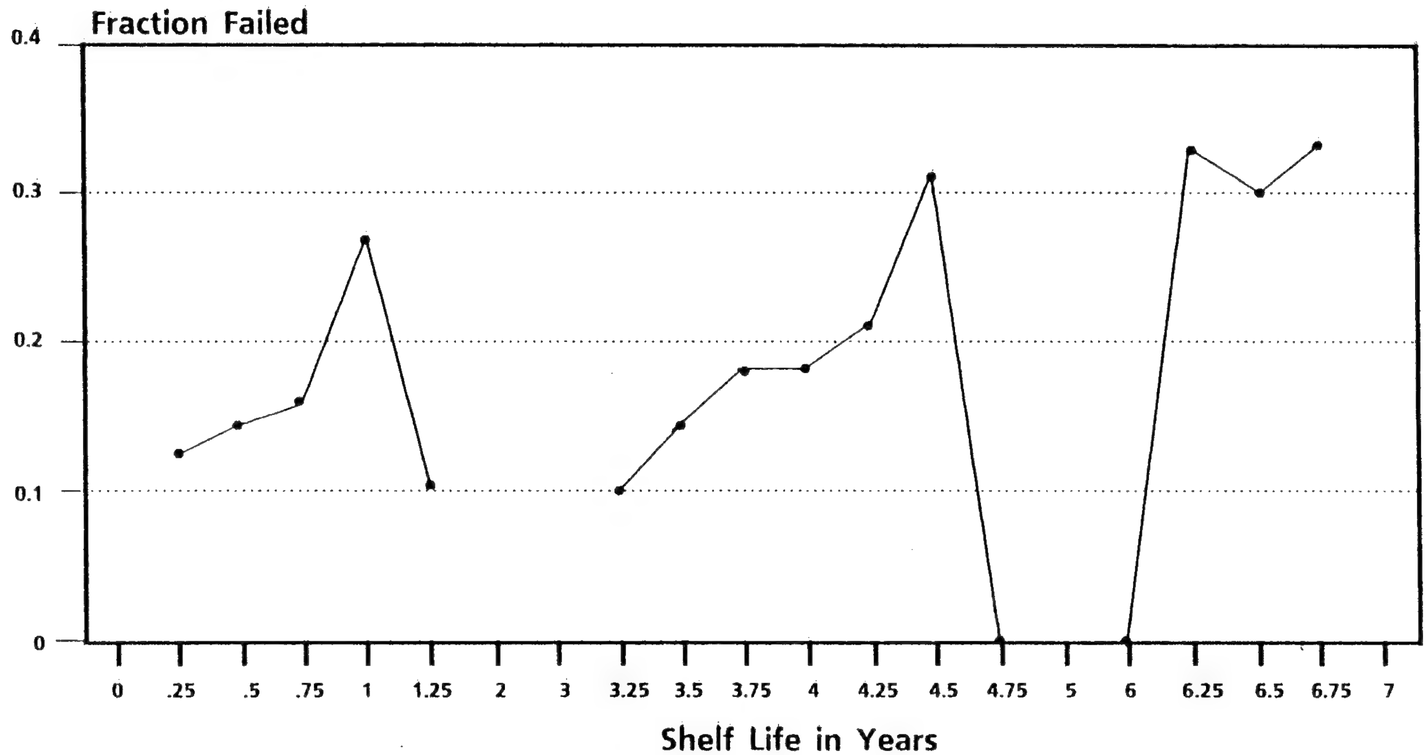
FRB	0	1	0	1	0	0	0	3	0	1	1	0	1	0	2	0	0	3	0	1	0
ETM	0	1	0	2	0	0	0	5	0	1	1	0	1	0	2	0	0	3	0	1	0
N	2	2	1	11	1	3	4	14	2	6	3	3	2	2	4	1	2	12	1	2	2
Wks	193	194	195	199	201	202	203	205	207	207	208	210	212	215	216	218	220	222	225	227	228
Av. Wks	198.25						204.8			210.7						222.85					

FRB	1	4	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0
ETM	1	4	0	0	0	0	0	0	0	1	0	0	1	1	1	1	1	0	0
N	2	7	1	1	1	1	1	1	1	2	1	1	3	3	3	1	2	2	1
Wks	228	231	232	233	234	235	236	243	309	326	330	339	339	341	342	356	359	362	363
Av. Wks	255.8												348.47						

Legend: Wks = Shelf Life in Weeks of the Tubes Tested or Screened
N = Sample Size for the Indicated Shelf Life
ETM = The Number of Tubes in Sample N that Failed the ETM Test
FRB = The Number of Tubes that Failed the FRB Screening
Av. Wks = The Average Shelf Life in Weeks per Group

AN/ALQ-131 OUTPUT TWTs

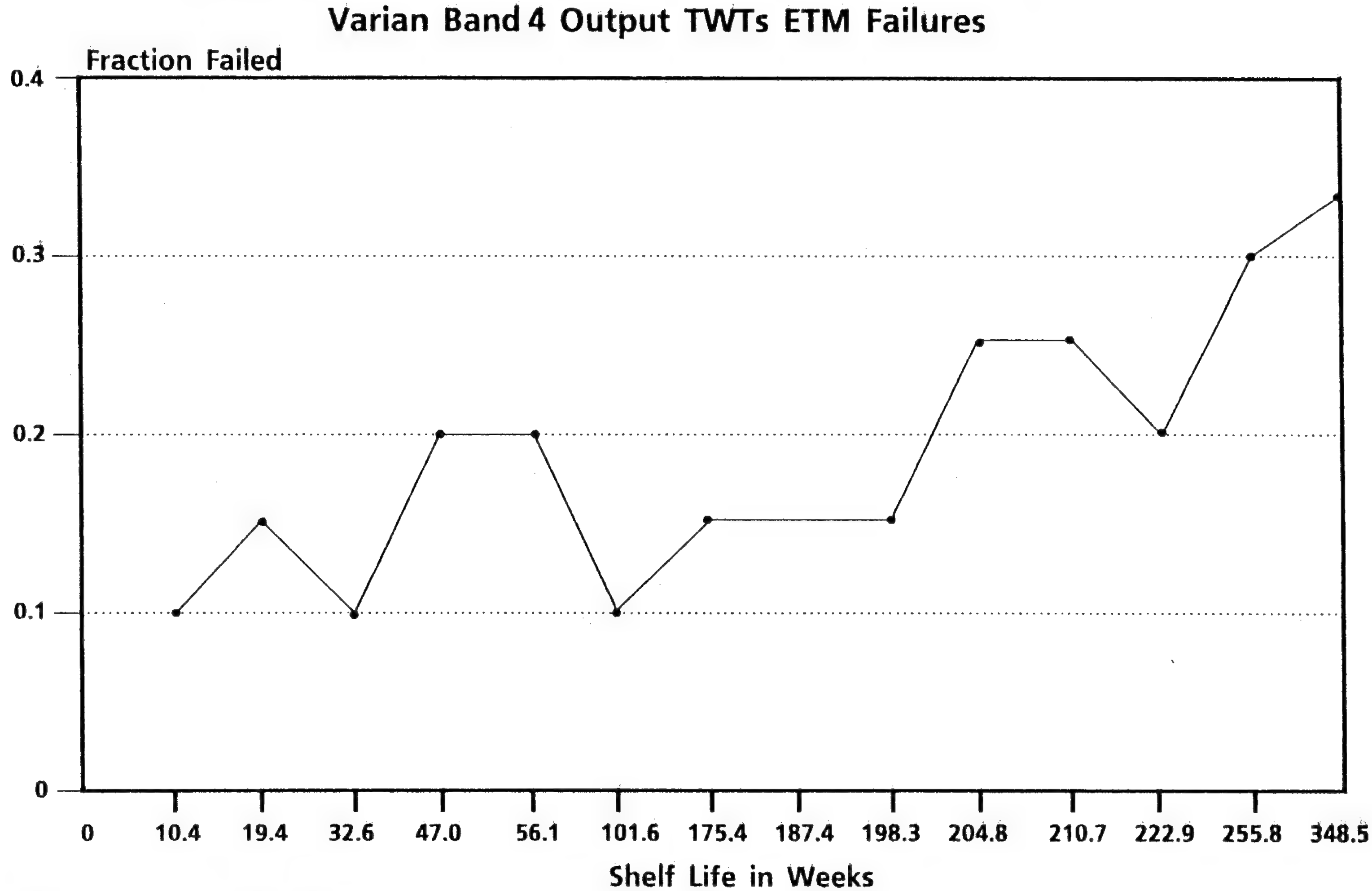
Varian Band 4 Output TWTs ETM Failures



Numbers above points show the quantity of TWTs
tested per quarter (low) and the quantity failed (high)

Figure 6.3.2 (a)

AN/ALQ-131 OUTPUT TWTs



Each point represents a fraction of failed TWTs in a sample of 20 (the last point is based on a sample of 15)

Figure 6.3.2 (b)

This suggests that the production of the Varian band 4 TWT's prior to the fourth year had an inherent ETM test yield of 75%. Then at the beginning of the fourth year an improvement in production (processes, materials, quality assurance, or other factors) increased the yield to 85%.

Whether or not this supposition is correct is not known, although Varian may possess the historical data to confirm or refute it. Nonetheless, the two yields flat line is one suggested model for this category. The other is the sloping straight line mentioned above. For this approach it was assumed that the plot in Figure 6.3.2 (c) is described by a line of the form

$$f = a + bt$$

Using the method of the least squares fit described in the appendix, the coefficients a and b were determined to be

$$f = .10934 + .0277t$$

where t is expressed in years. The line, shown in Figure 6.3.2 (c), bisects the set of fourteen points down the middle, seven above and seven below.

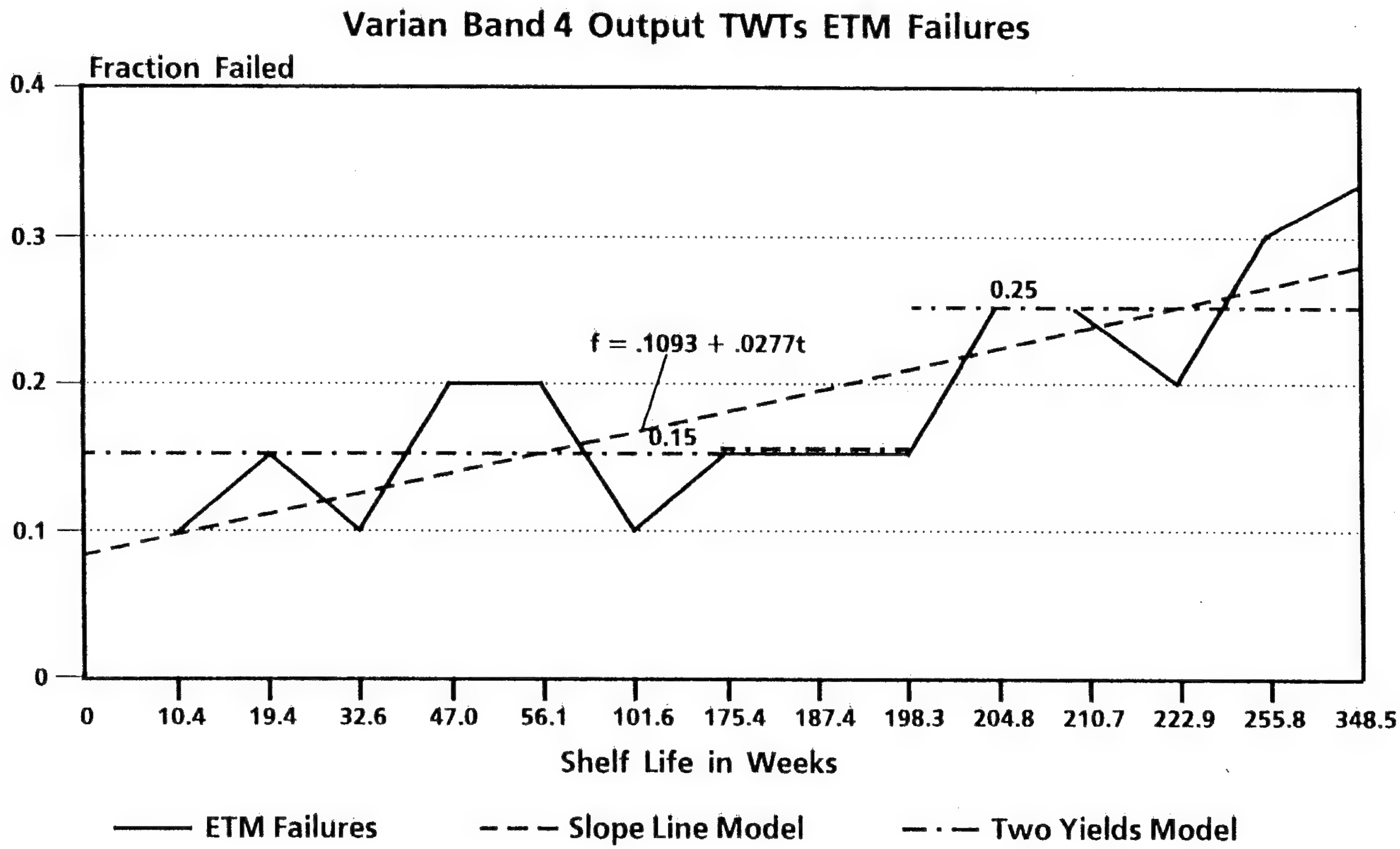
To judge which model fits the data better, the sum of squared deviations was computed for the sloped line above and the two yields line model, indicated by the dashed lines in Figure 6.3.2 (c), with the following results

$$\text{Error} = \sum_{i=1}^{14} (y_i - .1093 - .0277t_i)^2 = .0314$$

$$\text{Error} = \sum_{i=1}^{9} (y_i - 13/90)^2 + \sum_{i=10}^{14} (y_i - 8/30)^2 = .0196$$

Where the two constants 13/90 and 4/15 are the average values for the nine and six points respectively.

AN/ALQ-131 OUTPUT TWTs



Each point represents a fraction of failed TWTs in a sample of 20 (the last point is based on a sample of 15)

Figure 6.3.2 (c)

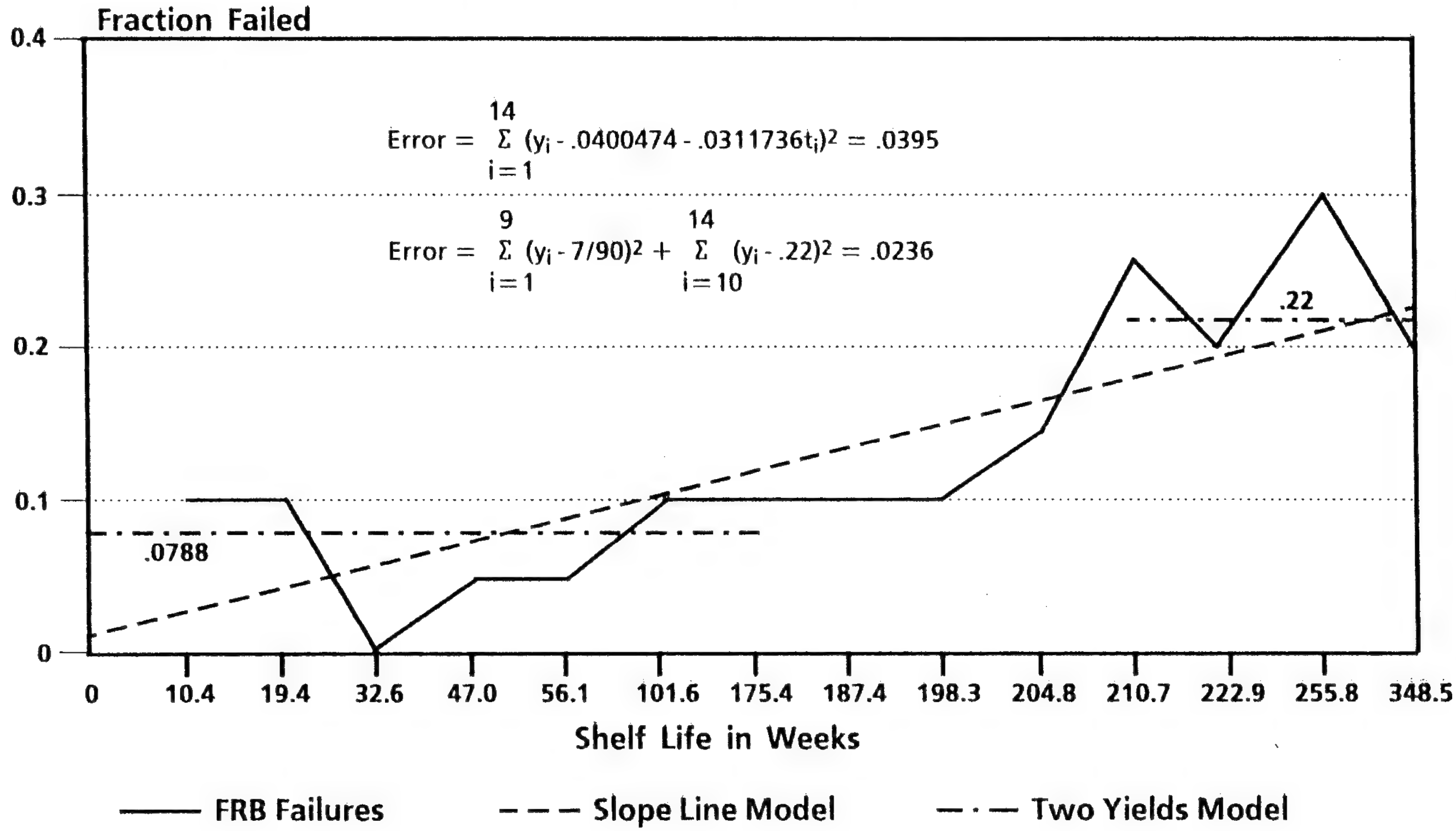
Thus, the two-yields model fits the data much closer than the sloped-line model. It may seem that since both models describe the same experimental data, the difference between them is insignificant or much ado about nothing. That is definitely not true. If one takes the sloped-line model seriously, it implies that the tubes start out with some basic yield or failure rate and that this failure rate will grow yearly by about 2.77% additively. To get the most out of procured tubes their shelf age should be minimized.

On the other hand, the two-yields model implies that the shelf life has no effect on the health of the tube; that its inherent yield remains constant throughout its shelf life. The yield may change as a result of other factors than the shelf age. Under this model there is no reason to minimize the shelf life of tubes or to worry about the shelf age at all.

The Varian band 4 category sustained 52 ETM failures in a total of 275 tubes tested. In addition to the ETM tests the failed tubes were reviewed by the FRB and 35 of them failed the FRB screening. The fraction of the FRB failures are plotted versus the average shelf life in Figure 6.3.2 (d). Here the two-yields model is even more obvious than in the ETM plot, the sloped-line model does not come to mind as readily when viewing it.

AN/ALQ-131 OUTPUT TWTs

Varian Band 4 Output TWTs FRB Failures



Each point represents a fraction of failed TWTs in a sample of 20 (the last point is based on a sample of 15)

Figure 6.3.2 (d)

To determine the levels for the two yields model the average ordinate values for the first nine points and for the last five points are calculated; they are 7/90 and .22 respectively. The sloped line for the FRB failures turns out to be

$$f = .0400474 + .0311736t; \quad t = \text{years}$$

The sum of squared deviations for these two competing models are

$$\text{Error} = \sum_{1}^{14} (y_i - .0400474 - .0311736t_i)^2 = .0395$$

$$\text{Error} = \sum_{1}^{9} (y_i - 7/90)^2 + \sum_{10}^{14} (y_i - .22)^2 = .0236$$

The two yields model is also victorious for the FRB failures but the two constant levels are lower than in the ETM case.

6.3.3 Band 4 TMEC TWTs

In this category there were five tubes tested on the ETM. One tube failed and upon the FRB screening it was passed as serviceable. The basic data for it is as follows:

FRB	0	0	0	0
ETM	0	0	1	0
N	2	1	1	1
WKS	8	12	13	14

It is remarkable only for its short shelf life. This will be found convenient in the composite case where short shelf life sample are rare. With this limited sample size one cannot comment on the distribution of failures in any aspect.

6.3.4 Band 5 Varian TWTs

The basic data for the Varian band 5 tubes is shown in Table 6.3.4 (a). There were 70 tubes tested on the ETM of which fourteen failed. The FRB screening rescued 9 of the ETM failures. The direct time plot of the ETM failures is shown in Figure 6.3.4 (a) where the time interval with the data spans about one year with rather sparse samples in the second half of the year. As in previous categories the basic data was partitioned into groups of ten samples for a total of seven groups. These were plotted at the average group shelf life and the result is shown in Figure 6.3.4 (b).

The ETM failure curve again suggests two possible models: a constant one where only the first and the last points deviate, and a sloped-line model. The latter was determined by the least squares fit method to be

$$f = .08284 + .171823t$$

where t is expressed in years again. Taking the constant to be .2 the sum of the squared deviations for the two models came out as follows

$$\text{Error} = \sum_{i=1}^{14} (y_i - .2)^2 = .08$$

$$\text{Error} = \sum_{i=1}^{14} (y_i - .08284 - .17182t_i)^2 = .0487$$

Table 6.3.4 (a) VARIAN Band 5 Output TWTs Test Results Versus Shelf Life in Weeks

FRB	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0
ETM	0	0	1	0	1	0	1	0	1	1	0	1	0	0	1
N	2	3	5	3	2	4	1	2	3	4	1	5	1	3	1
Wks	21	22	22	22	23	23	26	26	27	27	28	31	31	34	35
Av. Wks	21.6		22	22.4		23.6		26.6		27.2		31	33.6		

FRB	0	0	0	0	0	0	0	0	0	0	1	0	0	1
ETM	1	0	1	0	0	1	0	0	1	0	1	0	1	1
N	4	1	5	1	1	3	2	1	2	2	1	2	2	3
Wks	35	36	36	37	38	39	40	53	54	54	66	68	68	69
Av. Wks	35.2		36	38.4			48.2			62			68.6	

Legend:
Wks = Shelf Life in Weeks of the Tubes Tested or Screened
N = Sample Size for the Indicated Shelf Life
ETM = The Number of Tubes in Sample N that Failed the ETM Test
FRB = The Number of Tubes that Failed the FRB Screening
Av. Wks = The Average Shelf Life in Weeks per Group

AN/ALQ-131 OUTPUT TWTs

TMEC Band 5 TWTs ETM Failures

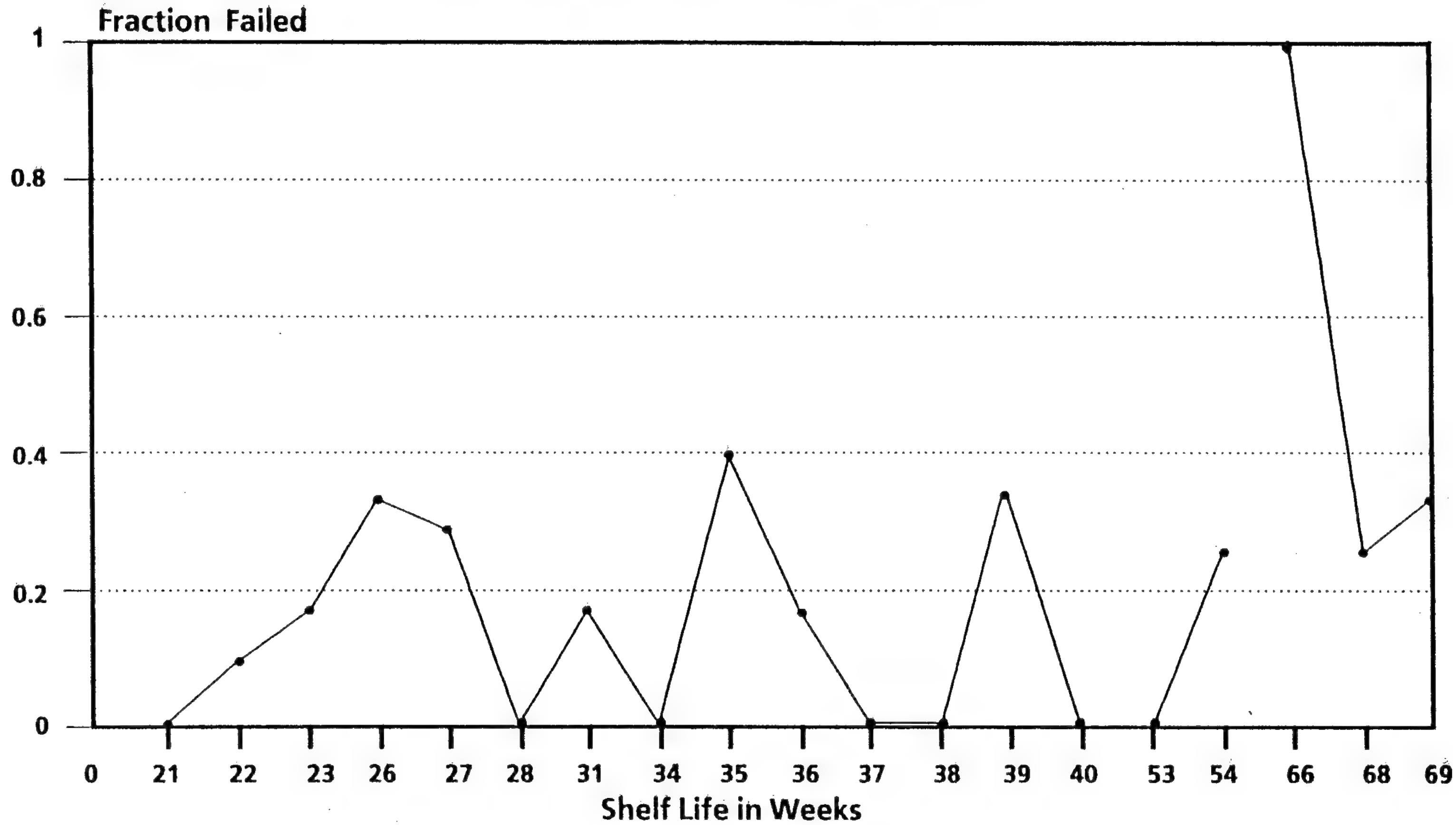


Figure 6.3.4 (a)

AN/ALQ-131 OUTPUT TWTs

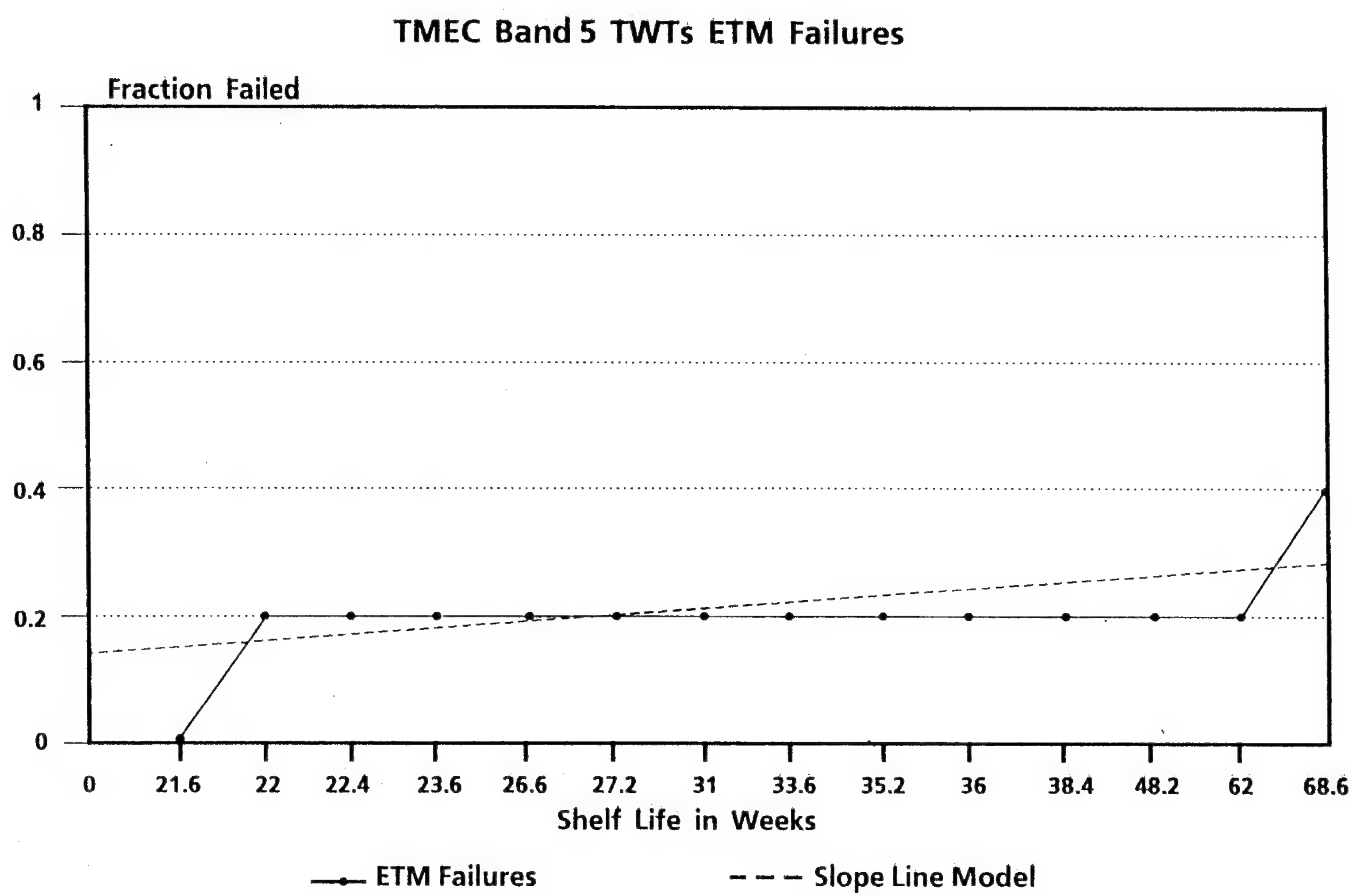


Figure 6.3.4 (b)

Thus, disregarding other factors, the sloped line is favored over the constant model for the ETM failures in this category. However, there are some serious difficulties with the sloped-line model here. First, the data spans only one year and most of it is concentrated in the first half of the year. Secondly, the slope is about six times higher for this category than it was for the Varian band 4 case.

In fact, it is so high that it predicts a finite shelf life of 5.4 years for this type of tube. On the other hand the constant model is entirely consistent with the two-yields model where it is assumed that the Varian band 5 data belongs to a single yield part. Had we assumed that the last point is the beginning of the second yield the two yields model would win since the last point would not contribute to the deviations.

$$\text{Error} = \sum_{i=1}^{13} (y_i - .2)^2 + (y_i - .4)^2 = .04$$

However, it is felt that a single point is not statistically significant enough to define a second yield level.

In the Varian band 5 output tubes there were only five FRB failures. The number of events is too low to make up a distribution or to conduct an analysis on them.

6.3.5 All New Output TWTs

Inspection of the summary results of the new output tubes shows that they are all very similar in character regardless of the band or vendor. This is particularly true of the ETM test results and the Code A ratings in spite of the fact that the sample sizes vary widely. In view of this data compatibility all output TWTs can be put into one category and analyzed as a single entity. The advantages of doing this are obvious. The sample size increases, the gaps in the time coverage are reduced, and the data that was too sparse for the individual analysis can finally be utilized quantitatively.

The basic data for all bands and vendors was put together and arranged in the increasing order of shelf life. The 389 samples were partitioned into groups of ten starting with the first nine for a total of 39 groups shown in Table 6.3.5 (a). The fraction of the tubes in a group that failed the FRB screening plotted versus the group average shelf life is presented in Figure 6.3.5 (a). Here, as was the case with the Varian band 4 category, two models suggest themselves to fit the data: the two-yields model and the sloped-line model. By inspection one can see that from zero up to 4.2 years the data follows a constant horizontal line where the average value is slightly below ten percent (.0852) since five points at .2 do not exactly cancel the ten at 0.

At the same time the last six points are equally divided into three up and three down to define a second constant yield level. It is less obvious that a gently sloped straight line may also be used to explain the expirical data of this graph. Using the method developed in the appendix, the least squares fit for a sloped line was calculated for this case with the result

$$f = .0466 + .02766t$$

Table 6.3.5 (a) All New Output TWTs Test Results Versus Shelf Life in Weeks

FRB	1	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	1	0
ETM	1	0	0	0	1	0	1	2	0	1	0	1	0	0	0	1	1	0	0	1	1	1	1
N	4	2	2	1	3	1	6	9	1	2	1	6	1	1	9	2	7	1	3	3	4	3	7
Wks	4	8	9	11	11	12	13	13	14	15	17	19	21	21	22	22	23	24	24	26	27	27	28
Av. Wks	6.1				12.3			13.1		18.2				21.9		22.9			25.8			27.7	

FRB	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
ETM	0	0	0	1	0	0	1	1	1	0	1	0	1	0	0	0	0	4	3	0	0
N	6	1	3	3	1	3	3	3	6	1	4	1	3	2	8	2	3	7	6	1	3
Wks	28	29	31	31	33	34	35	35	36	37	37	38	39	40	42	46	46	50	50	51	54
Av. Wks	29.0			33.3				35.8			38.3				42.8		48.8		51.3		

FRB	0	0	0	0	1	0	0	2	1	0	1	0	0	0	1	0	0	1	0	0	0	0
ETM	1	0	0	0	1	0	0	2	1	1	1	0	0	0	1	1	0	1	0	0	0	0
N	4	1	3	2	5	5	5	5	1	4	3	1	1	5	1	3	1	4	2	2	1	1
Wks	54	55	56	58	58	60	60	63	66	68	69	82	104	104	106	107	108	108	109	111	113	114
Av. Wks	55.5				59		61.5		73.2					105.5				109.9				

FRB	1	0	0	0	0	0	0	0	0	1	0	0	0
ETM	1	0	0	0	0	0	0	0	0	1	0	0	0
N	3	2	1	1	2	1	1	1	2	2	1	1	2
Wks	114	124	127	129	144	147	148	149	152	154	156	158	159
Av. Wks	128.1						154.6						

Legend: Wks = Shelf Life in Weeks of the Tubes Tested or Screened
N = Sample Size for the Indicated Shelf Life
ETM = The Number of Tubes in Sample N that Failed the ETM Test
FRB = The Number of Tubes that Failed the FRB Screening
Av. Wks = The Average Shelf Life in Weeks per Group

Table 6.3.5 (a) All New Output TWTs Test Results Versus Shelf Life in Weeks (cont'd.)

FRB	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
ETM	0	0	1	1	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0
N	1	1	5	3	1	1	5	3	1	1	3	3	1	1	3	1	1	1	3	1
Wks	160	162	166	172	174	175	176	177	177	180	181	182	184	185	185	186	187	188	189	190
Av. Wks	166.7				176.0				181.5						187.3					

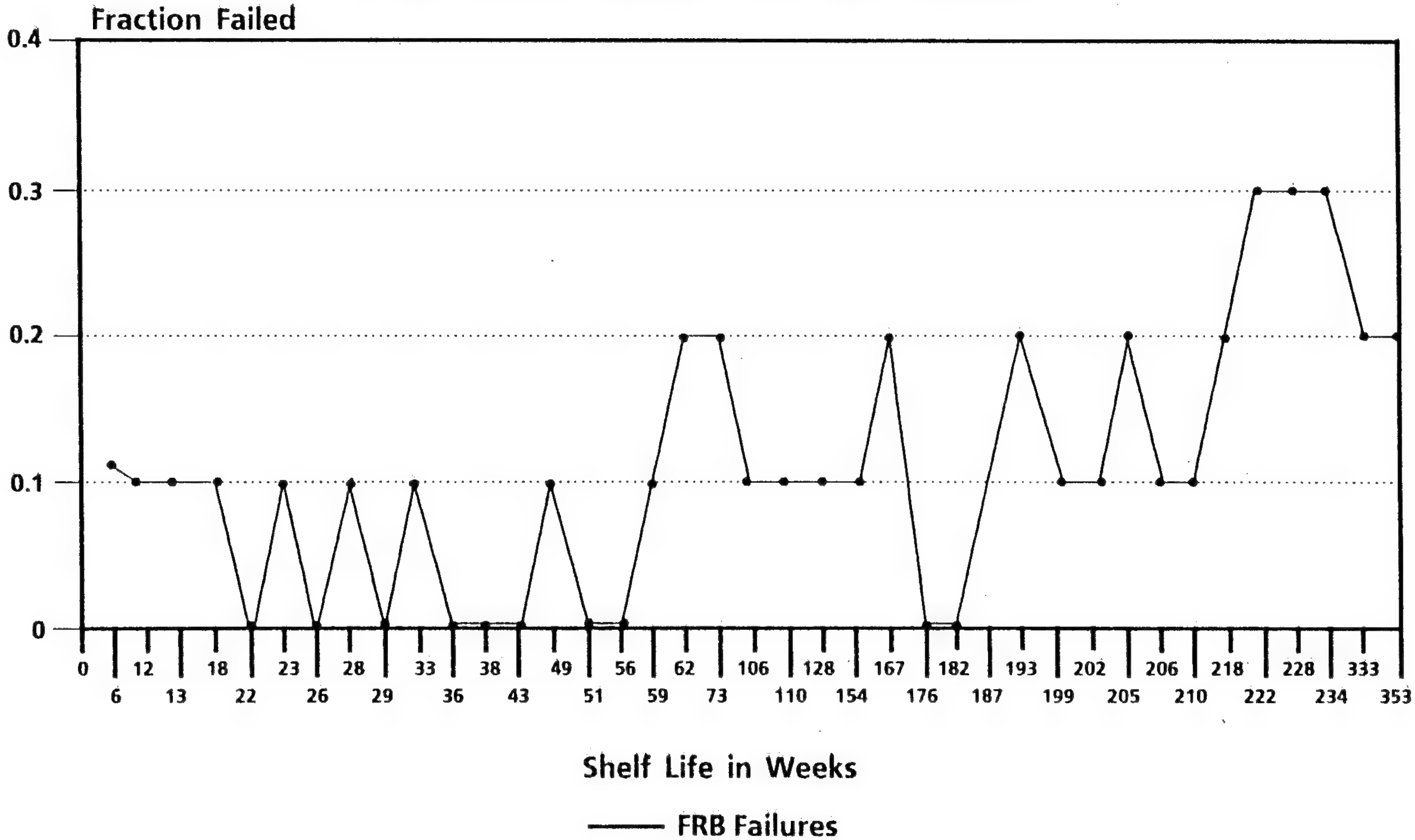
FRB	1	0	1	0	1	0	0	0	0	1	2	0	1	0	0	0	1	0	0	2	0	0	0
ETM	2	0	1	0	2	0	0	0	0	1	3	1	1	0	0	0	1	0	0	2	0	0	0
N	5	2	2	1	10	1	1	3	4	1	10	3	7	1	3	3	2	1	1	4	1	2	2
Wks	192	193	194	195	199	199	201	202	203	205	205	205	207	207	208	210	212	215	215	216	218	220	222
Av. Wks	192.9				199	202.3					205	206.4		210.0					218.1				

FRB	3	0	1	1	1	3	0	0	0	0	0	0	0	1	0	1	0	1	1	0	0	0	0
ETM	3	0	1	1	1	3	0	0	0	0	0	0	0	1	0	1	0	1	1	1	0	0	0
N	10	1	2	4	3	4	1	1	1	1	1	1	1	2	1	4	2	1	3	1	2	2	1
Wks	222	225	227	228	231	231	232	233	234	235	236	243	309	326	330	339	341	341	342	356	359	362	363
Av. Wks	222	228.4				233.7							332.9					352.8					

Legend: Wks = Shelf Life in Weeks of the Tubes Tested or Screened
N = Sample Size for the Indicated Shelf Life
ETM = The Number of Tubes in Sample N that Failed the ETM Test
FRB = The Number of Tubes that Failed the FRB Screening
Av. Wks = The Average Shelf Life in Weeks per Group

AN/ALQ-131 OUTPUT TWTs

Varian Band 5 Output TWTs FRB Failures



Each point is based on a sample of 10

Figure 6.3.5 (a)

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

The goodness of fit of each model was then judged by the sum of squared deviations. They were

$$\text{Error} = \sum_{i=1}^{33} (y_i - .0852)^2 + \sum_{i=34}^{39} (y_i - .25) = .158$$

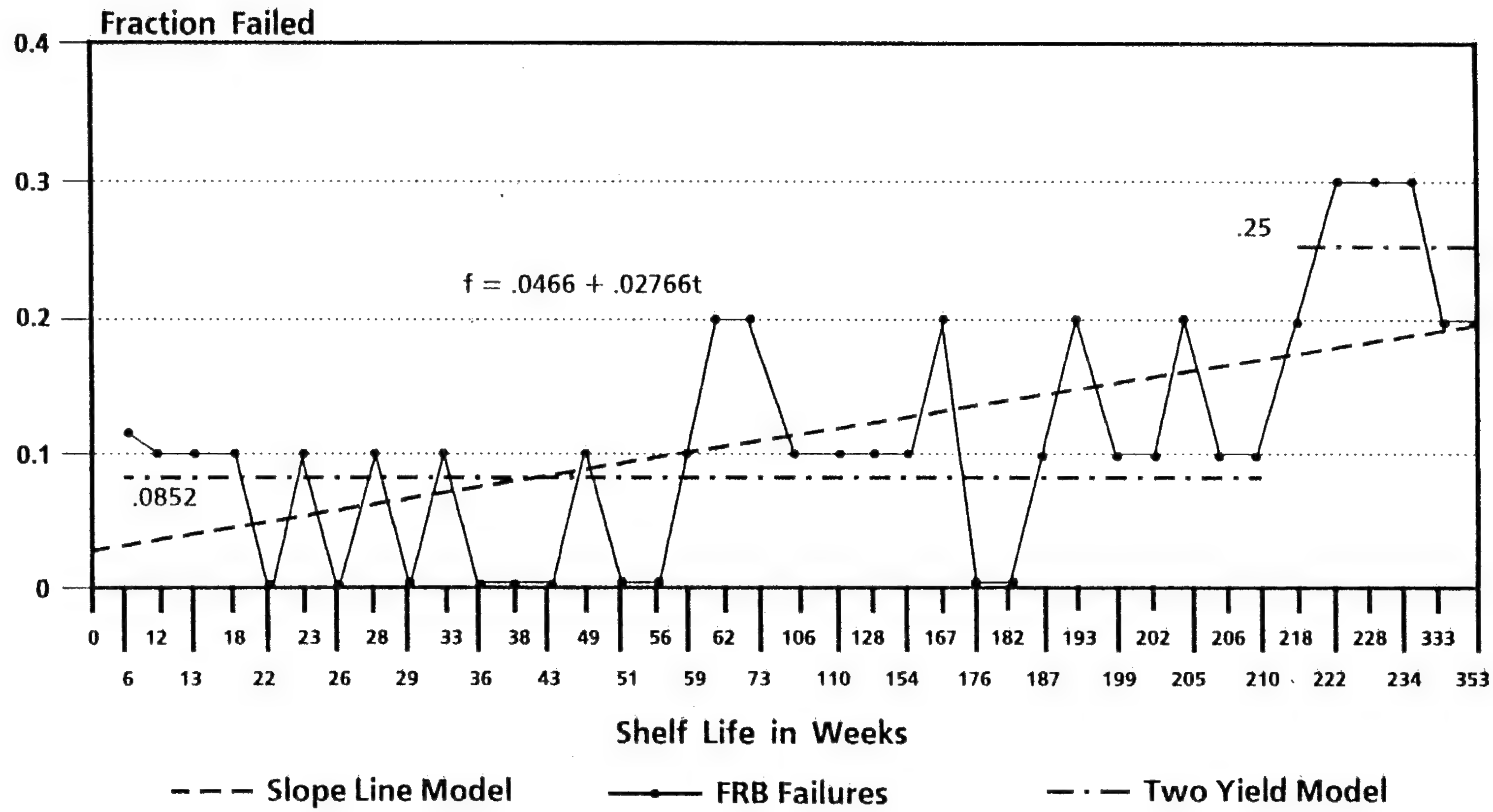
$$\text{Error} = \sum_{i=1}^{39} (y_i - .0466 - .02766t_i)^2 = .176$$

As is illustrated in Figure 6.3.5(b) the two yields model, where in the first four years the failure rate is about 8.5 percent and beyond four years it s twenty-five percent, fits the data better than the sloped-line model.

A similar analysis was done on the ETM failures for the same class of TWTs. Using the basic data of Table 6.3.5 (a) two groups per one data point were plotted versus the average age of the two groups. The increase of the sample size from ten to twenty gave a smoother curve with a more distinct trend in it. However, the last group having no match was of necessity limited to just ten samples. The ETM failure plot is shown in Figure 6.3.5 (c). Again visual inspection suggests that there are two levels of failure, a low one extending over the first four years and a higher one for the remainder of the time axis.

AN/ALQ-131 OUTPUT TWTs

Varian Band 5 Output TWTs FRB Failures



Each point is based on a sample of 10

Figure 6.3.5 (b)

AN/ALQ-131 OUTPUT TWTs

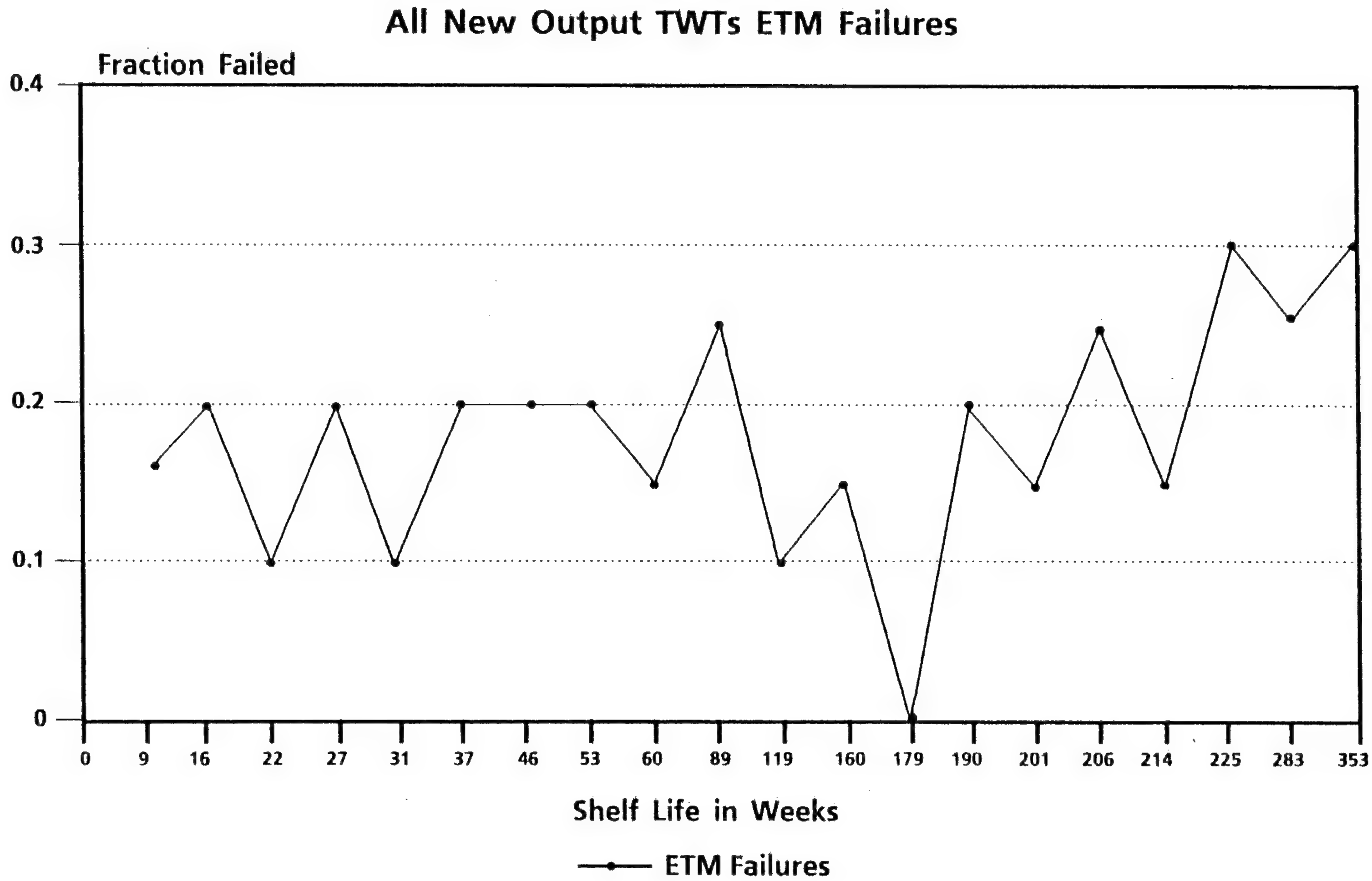


Figure 6.3.5 (c)

In addition to this two yields model, a sloped-line model is another possibility. The better, determined in accordance with the least squares fit, gives the line

$$f = .1474 + .01363t$$

where t is in years. Computations of the sum of squared deviations for these two models gave the result

$$\text{Error} = \sum_{i=1}^{16} (y_i - .163)^2 + \sum_{i=17}^{20} (y_i - .25)^2 = .0508$$

$$\text{Error} = \sum_{i=1}^{20} (y_i - .1474 - .01363t_i)^2 = .0882$$

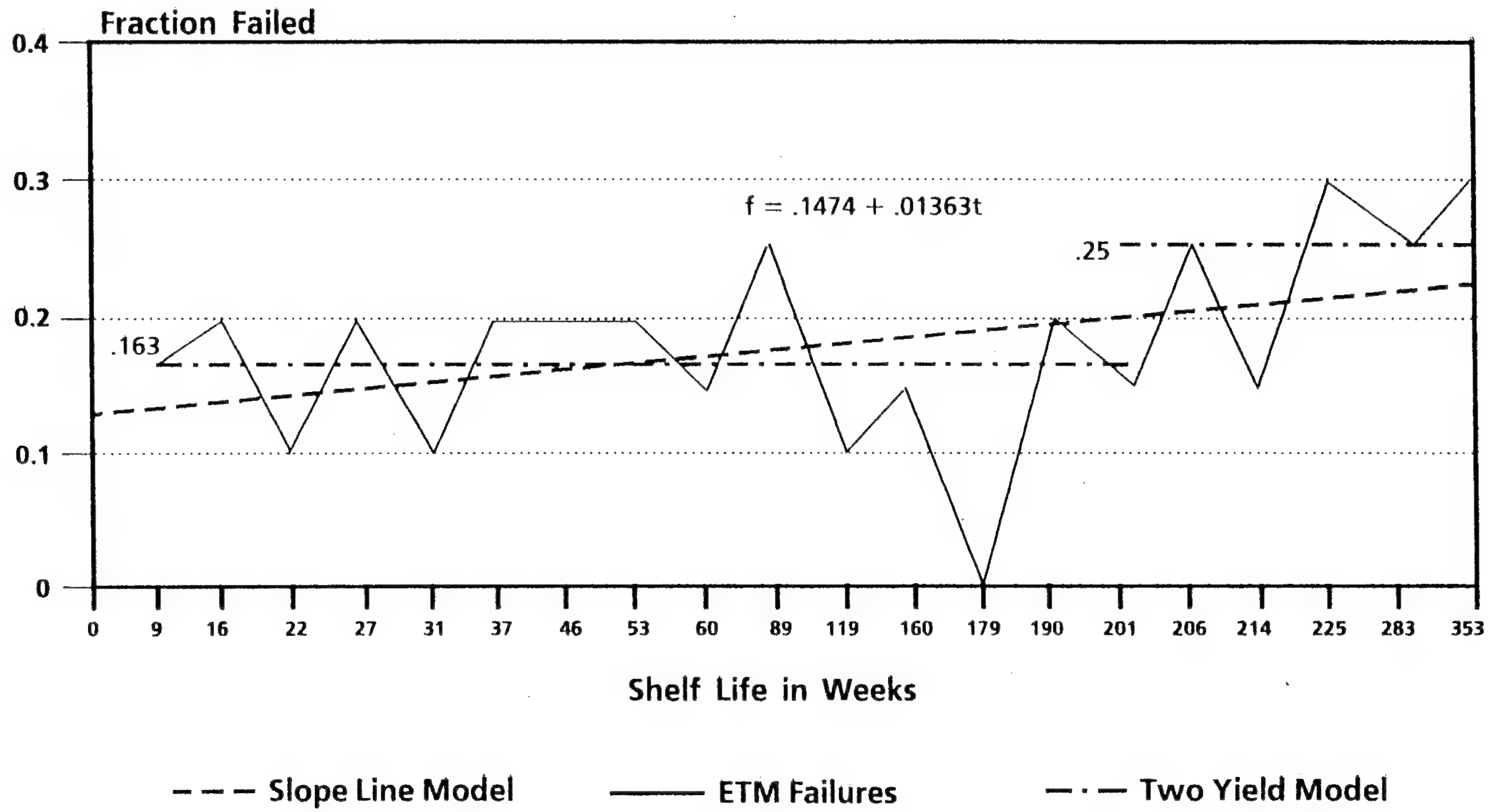
which also favors the two yields model. Note that the failure rate of .163 is the average for the first 16 points and .25 is the average of the last four points of the plot in Figure 6.3.5 (d). The two competing models are illustrated in Figure 6.3.5 (d).

It is seen that both for the FRB failures as well as the ETM failures visual inspection, the goodness of fit, a lack of signs of aging or deterioration or of gassy tubes among the failed TWTs lend us to the following conclusions as far as the output tubes go:

1. The output TWT failure rate is a constant, an inherent characteristic of its production and delivery processes.
2. The failure rate may change as a result of production and delivery improvements or degradation assuming a different constant level abruptly, a finite jump in time.
3. The shelf life has no effect on the tubes failure rate.
4. The two extremes of the Weibull distribution about the constant failure rate case, that is the high initial rate (infant mortality) and the ever increasing failure rate proportion to t^x, where $x>0$, are not supported by the output tubes data. The detailed ETM failure data near the time origin are shown in Figure 6.3.5 (e) betraying no infant mortality characteristics. The data at the other end of the time interval up to four years is flat and non-increasing: after four years it is again flat, but at a higher level.

AN/ALQ-131 OUTPUT TWTs

All New Output TWTs ETM Failures



Each point is based on a sample of 10

Figure 6.3.5 (d)

AN/ALQ-131 OUTPUT TWTs

All New Output TWTs Test Results

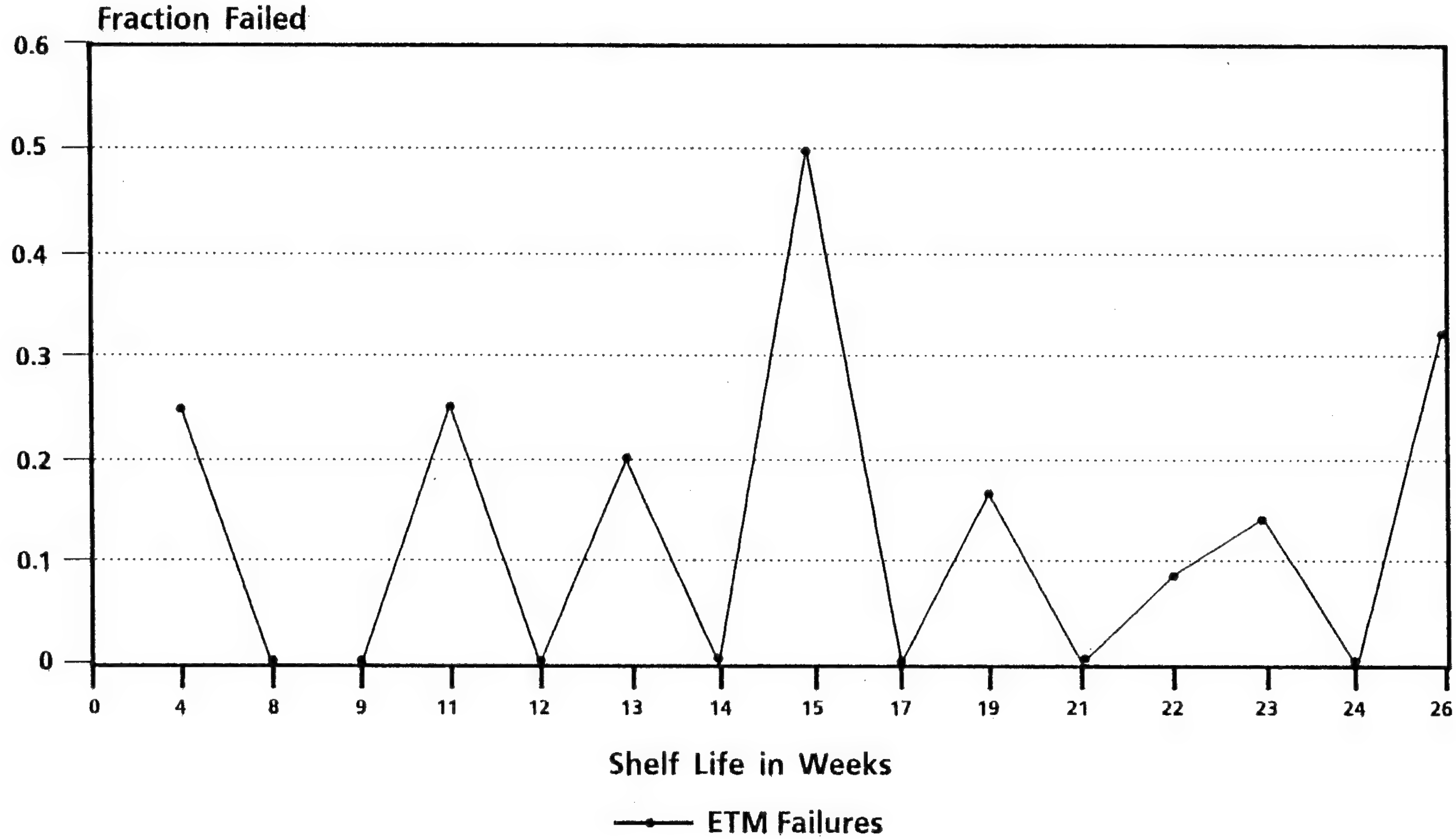


Figure 6.3.5 (e)

7.1.12 Failure Code 12 - Second Stage Inoperative

TWTs that exhibited characteristics of an inoperative second stage. These TWTs did not have a measurable output in either gain or power.

7.1.13 Failure Code 13 - Mechanical

TWTs that failed to meet the outline drawing specification. Examples of mechanical problems are: damaged SMA connectors, damaged outer case, etc.

7.1.14 Failure Code 14 - Other

TWTs which had failures not covered by the thirteen (13) failure codes mentioned above.

7.2 Detailed Test Results

Data was collected on each driver TWT and entered into a data base during the laboratory screening. The data included shipping and receiving information, physical inspection information, TWT operational data, and failure code information. The failure codes were described in paragraph 7.1 and represent the failure symptom monitored during screening. The actual cause of failure can only be determined through failure analysis for each TWT.

A summary of the failure code information is depicted in Table 7.2 (a). This information is broken down by vendors and bands. The quantities shown represent the total number of tubes that had a particular failure code. It is important to note that each TWT may have more than one failure code. For example, a TWT may have failed the laboratory screening for first-stage thirty-minute low again and second-stage low power. Therefore, that TWT would have had failure codes 3 and 6. There was a maximum of three failure codes recorded for each TWT.

A summary of the date code information is depicted in Table 7.2 (b). This information is broken down by vendors and bands. The quantities shown represent the total number of tubes screened with a particular date code. The date codes for the driver TWTs range from 1983 through 1989. The totals for new and used TWTs are also shown.

7.2.1 Program Summary: New Band 4 and 5 TWTs

A total of 150 Band 4 driver TWTs were screened during the contract. One hundred forty-eight (698.7%) of the 150 Band 4 TWTs were returned to Warner Robins ALC as serviceable, and 2 (1.3%) were returned as unserviceable (Appendix D, page D-1).

A total of 300 Band 5 driver TWTs screened during the contract. One hundred two (34%) of the 300 Band 5 TWTs were returned to Warner Robins ALC as serviceable. Four (1%) TWTs were returned to Warner Robins ALC as unserviceable, and 194 (65%) are being held at the Regional Service Center pending further study (Appendix D, page D-1).

7.0 ANALYSIS: DRIVER TWTS

A data base was established to collect all screening data on each TWT. TWTs that failed the laboratory bench test were assigned failure codes from numbers 1 through 14.

7.1 Failure Codes

To categorize the failure data a series of failure codes were assigned for the most frequent failures. The maximum number of failure codes assigned to each TWT was three. The fourteen (14) failure codes used for driver TWT screening are listed below:

7.1.1 Failure Code 1 - First Stage 3-Minute Gain

TWTs that failed to meet the first stage gain specifications after a three-minute warm-up.

7.1.2 Failure Code 2 - Second Stage 3-Minute Gain

TWTs that failed to meet the second stage gain specifications after a three-minute warm-up.

7.1.3 Failure Code 3 - First Stage 30-Minute Gain

TWTs that failed to meet first stage gain specifications after a thirty-minute warm-up.

7.1.4 Failure Code 4 - Second Stage 30-Minute Gain

TWTs that failed to meet second stage gain specifications after a thirty-minute warm-up.

7.1.5 Failure Code 5 - First Stage Power

TWTs that failed to meet first stage power specifications.

7.1.6 Failure Code 6 - Second Stage Power

TWTs that failed to meet second stage power specifications.

7.1.7 Failure Code 7 - First Stage Noise Figure

This failure code was assigned to TWTs that failed to meet the first stage noise figure specification.

7.1.8 Failure Code 8 - Second Stage Noise Figure

TWTs that failed to meet the second stage noise figure specification.

7.1.9 Failure Code 9 - First Stage Gain Variation

TWTs that failed to meet the first stage gain variation specification.

7.1.10 Failure Code 10 - Second Stage Gain Variation

TWTs that failed to meet the second stage gain variation specification.

7.1.11 Failure Code 11 - First Stage Inoperative

TWTs that exhibited characteristics of an inoperative first stage. These TWTs did not have a measurable output in either gain or power.

7.2.2 Program Summary: Used Band 3 TWTs

The used Driver TWTs were tubes that had previously failed in the field, but had been returned to the USAF supply system as serviceable. All of the Band 3 TWTs received during this contract were used. There was a total of 64 Band 3 Litton used TWTs screened. Forty-eight (75%) of the 64 Band 3 TWTs were returned to Warner Robins ALC as serviceable, and 16 (25%) were returned as unserviceable (Appendix D, page D-2).

7.2.3 Screening Summary: New Versus Used TWTs

A total of 450 new TWTs were screened on the laboratory test bench. One hundred ninety (42%) of the 450 TWTs passed the screening tests, and 260 (58%) failed.

The 260 TWTs that failed the screening tests were referred to the FRB for final disposition (Appendix D, page D-3).

A total of 64 used TWTs were screened on the laboratory test bench. Thirty (47%) of the 64 TWTs passed the screening tests and 34 (53%) failed. The 34 TWTs that failed the screening tests were referred to the FRB for final disposition (Appendix D, page D-3).

7.2.4 Screening Summary: New Versus Used TWTs by Failure Code

There is a noticeable difference in the distribution of failure codes between new and used driver TWTs (Appendix D, page D-4).

The new driver TWTs had higher failures in (1) first stage three-minute gain, failure code 1, (2) second stage three-minute gain, failure code 2, (3) first stage thirty-minute gain, failure code 3, (4) first stage power, failure code 5, (5) first stage noise figure, failure code 7, (6) first stage gain variation, failure code 9, and (7) mechanical, failure code 13.

The used driver TWTs had higher failures in (1) second stage thirty-minute gain, failure code 4, (2) second stage power, failure code 6, (3) second stage gain variation, failure code 10, (4) first stage inoperative, failure code 11, and (5) second stage inoperative, failure code 12.

Failure Codes (Total Failures) *															
Vendor	Band	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Litton (Used)	3	4	10	4	7	2	16	9	2	1	1	8	3	0	2
Litton (New)	4	112	3	20	1	1	2	2	1	5	0	2	0	1	0
Litton (New)	5	276	55	216	4	31	11	83	1	1	0	1	0	0	2
Subtotal (Used)		4	10	4	7	2	16	9	2	4	1	8	3	0	2
Subtotal (New)		388	58	236	5	32	13	85	2	6	0	3	0	1	2
Totals		392	68	240	12	34	29	94	4	10	1	11	3	1	4

Table 7.2 (a) Driver TWT Failure Codes by Vendor

* Each TWT may have more than one failure code

Date Code *									
Vendor	Band	1983	1984	1985	1986	1987	1988	1989	Total
Litton (Used)	3	1	13	16	30	4	0	0	64
Litton (New)	4	0	0	30	49	24	35	12	150
Litton (New)	5	0	0	46	97	77	73	7	300
Subtotal (Used)		1	13	16	30	4	0	0	64
Subtotal (New)		0	0	76	146	101	108	19	450
Totals		1	13	92	176	105	108	19	514

Table 7.2 (b) Driver TWT Failure Date Codes by Vendor

* Quantity of TWTs tested each year

The new driver TWTs exhibited a high quantity of first stage three-minute gain, failure code 1, failures. Three hundred eighty-eight (86%) of the new TWTs compared to 4 (6%) of the used TWTs failed for three-minute gain. The new driver TWTs also exhibited a high quantity of first stage thirty- minute gain, failure code 3, failures. Two hundred thirty-six (52%) of the new TWTs compared to 4 (6%) of the used TWTs failed for thirty-minute gain. The third highest failures were first stage noise figure, failure code 7. Eighty-five (19%) of the new TWTs compared to 9 (14%) of the used TWTs failed for first stage noise figure.

It was not in the scope of this contract to analyze all of the failure modes of the TWTs. This would be appropriate in the future when part of the TWTs can be returned to the manufacturer for failure analysis.

7.2.5 Screening Summary: Band 3, 4, and 5 Failure Rate Over Time by Failure Code

The graphs in Appendix D, pages D-5 through D-18 depict the failure rate over time for each of the fourteen failure codes. The date codes of the TWTs screened range from 1983 through 1989. It is important to note that these graphs include all three bands which consists of both new and used TWT. Problems mentioned in this section will be narrowed down to an individual band and vendor in later graphs.

From 1985 through 1989 failure code 1, first stage three-minute gain, exhibited a high rate of failure. Further investigation by the vendor should be done on these TWTs in order to find a solution to this problem.

From 1984 through 1988 failure code 2, second stage three-minute gain, also exhibited a high rate of failure. This rate, ranging from 8% to 21%, is lower than the first stage three-minute gain, but should also be investigated to find a solution to the problem.

From 1984 through 1989 failure code 3, first stage thirty-minute gain, exhibited a high failure rate ranging from 15% to 63%. There should also be further investigation on this problem to find a suitable solution.

From 1984 through 1989 failure code 5, first stage power, exhibited a failure rate ranging from 5% to 12%. This problem could be related to the gain problems mentioned above, but further investigation should be performed to determine if it is or not. From 1985 through 1989 failure code 7, first stage noise figure exhibited a high failure rate ranging from 16% to 21%. If a TWT exhibits low gain, it will also have a high noise figure. Therefore, this problem is related to the gain failures mentioned above.

7.2.6 Screening Summary: Band 3 Litton (Used)

A total of 64 Band 3 Litton driver TWTs were screened during this contract. Thirty (47%) of the TWTs passed the laboratory bench tests. Thirty-four (53%) of the TWTs were referred to the FRB for disposition (Appendix D, page D-19).

7.2.7 Screening Summary - Band 3 Litton (Used) Failure Rate Over Time by Failure Code

The graphs in Appendix D, pages D-20 through D-32 depict the failure rate over time for thirteen of the fourteen failure codes. No TWTs failed for mechanical problems, failure code 13. The date codes range from 1983 through 1987.

From 1984 through 1986 failure code 2, second stage three-minute gain, exhibited an increasing failure rate from 8% to 23%.

From 1984 through 1987 failure code 6, second stage power, exhibited failure rates ranging from 17% to 50%.

The remaining failure codes did not exhibit any noticeable patterns. The failure rates were random of the date code range. The cause of the second stage problems mentioned above needs to be analyzed in the future.

7.2.8 Screening Summary: Band 3 Litton (Used) Failure Code Distribution by Date Code

The graphs in Appendix D, pages D-33 through D-36 depict the failure code distribution over time for the Band 3 Litton TWTs. The charts show that the failures for each date code are distributed throughout the failure code range.

7.2.9 Screening Summary: Band 3 Litton (Used) by Failure Code

The graph in Appendix D, page D-37 shows that the failures for the Band 3 TWTs are distributed throughout the failure code range. The largest quantity of failures occurred in failure code 6, second stage power. Failure code 2, second stage three-minute gain, and failure code 7, first stage noise figure had the next highest failures.

7.2.10 Screening Summary: Band 4 Litton (New)

A total of 150 Band 4 Litton (new) driver TWTs were screened. One hundred nineteen (79%) passed the laboratory bench test and 31 (21%) failed (Appendix D, page D-38). The 31 failures were referred to the FRB for disposition.

7.2.11 Screening Summary: Band 4 Litton (New) Failure Rate Over Time by Failure Code

The graphs in Appendix D, pages D-39 through D-49 depict the failure rate over time for eleven of the fourteen failure codes. No Band 4 Litton TWTs failed for failure codes 10, 12, or 14. The date codes range from 1985 through 1989.

First stage three-minute gain, failure code 1 exhibited a high failure rate throughout the date code range. The failure rates ranged from 58% to 97%. This was a major problem with this particular TWT. First stage thirty- minute gain, failure code 3, also exhibited a high failure rate. The failure rates ranged from 10% to 25% from 1985 through 1988. The remaining failure codes did not exhibit any noticeable pattern. The first stage problem needs to be investigated in the future.

7.2.12 Screening Summary: Band 4 Litton (New) Failure Code Distribution by Date Code

The graphs in Appendix D, pages D-50 through D-54 depict the failure code distribution over time for the Band 4 Litton driver TWT. These graphs also emphasize the problem with the first stage three-minute gain, failure code 1, mentioned above.

7.2.13 Screening Summary: Band 4 Litton (New) by Failure Code

The two noticeable failures in this graph are failure code 1, first stage three-minute gain, and failure code 3, first stage thirty-minute gain (Appendix D, page D-55). This graph re-emphasizes the first stage problem mentioned above.

7.2.14 Screening Summary: Band 5 Litton (New)

A total of 300 Band 5 Litton TWTs were screened. Seventy-one (24%) passed the laboratory bench test, and 229 (76%) failed (Appendix D, page D-56). This particular TWT appears to have a major problem in the first stage which will be discussed in the following set of graphs. As a result of this problem a six-month shelf life study was initiated. This study will be completed in June 1991.

7.2.15 Screening Summary: Band 5 Litton (New) Failure Rate Over Time by Failure Code

The graphs in Appendix D, pages D-57 through D-67 depict the failure rate over time for eleven of the fourteen failure codes. No Band 5 TWTs failed for failure codes 10, 12, or 13. The date codes range from 1985 through 1989.

Failure code 1, first stage three-minute gain, exhibited a high failure rate throughout the date code range. The failure rates ranged from 86% to 96%. Failure code 2, second stage three-minute gain, exhibited failure rates ranging from 6% to 29% from 1985 to 1988. This problem is not as extreme as the first stage three-minute gain, but it should also be investigated in the future.

Failure code 3, first stage thirty-minute gain, also exhibited a high failure rate throughout the date code range. The failure rates ranged form 54% to 85%.

Failure code 5, first stage power, exhibited failure rates of ranging from 6% to 14% throughout the date code range. This problem could be related to the high failure rates observed in the first stage thirty-minute gain.

Failure code 7, first stage noise figure, exhibited failure rates ranging from 23% to 43% throughout the date code range. This problem is related to the high failure rates observed in the first stage thirty-minute gain since average gain is used to calculate the noise figure.

7.2.16 Screening Summary: Band 5 Litton (New) Failure Code Distribution by Date Code

The graphs in Appendix D, pages D-68 through D-72 depict the failure code distribution over time for the Band 5 Litton TWTs. These graphs also support the findings of the previous graphs. The highest failures rates are in (1) first stage three-minute gain, failure code 1, (2) first stage thirty-minute gain, failure code 3, (3) first stage noise figure, failure code 7, and (4) second stage three-minute gain, failure code 2.

7.2.17 Screening Summary: Band 5 Litton (New) by Failure Code

This graph also supports the findings from the previous graphs (Appendix D, page D-73). The highest quantity of failures occurred in (1) first stage three-minute gain, failure code 1, (2) first stage thirty- minute gain, failure code 3, (3) first stage noise figure, failure code 7, and (4) second stage three-minute gain, failure code 2.

7.3 STATISTICAL ANALYSIS

7.3.1 Band 4 Litton TWTs

The new driver TWTs of bands 4 and 5 came from the single manufacturer, Litton. The driver data was organized and analyzed in the same manner as the output TWT data. It should be noted that the FRB failed only two TWTs through their screening, therefore, no quantitative analysis of these failures is possible due to the paucity of events. On the other hand, the bench test failures, after thirty minutes of warm-up time, were numerous and the analysis below deals exclusively with these failures. The Litton band 4 basic data is shown in Table 7.3.1 (a). The average failure rate oscillates about the value of .2 or 20 percent. [Figure 7.3.1 (a)] However, one cannot help but notice the negative trend for the failed fraction as a function of shelf age. A straight line derived from the least squares fit approach of the appendix supports this intuitive interpretation, yielding the line

$$f = .378 - .0391t \ ; \ t = \text{shelf age in years}$$

with the negative slope [Figure 7.3.1 (b)]. In the previous analysis the sloped line and a flat, horizontal line often completed for dominance. To this end, the sum of squared deviations was computed for the average failure rate of .2 and for the sloped line above. The results are

$$\text{Error} = \sum_{i=1}^{15} (y_i - .2)^2 = .22$$

$$\text{Error} = \sum_{i=1}^{15} (y_i - .328 + .0391t_i)^2 = .172$$

The negative sloped line gives a better fit to the data indicating that the newer production TWTs have poorer yields than the older tubes. One has to attribute this to degradation in some or a combination of all factors underlying production such as processes, procedures, materials, quality assurance, etc.

Now that degradation in yield for the newer tubes is admitted, the model that the negatively sloped line should compete with is not one overall failure rate but two different constant failure rates. A closer examination of Figure 7.3.1 (b) graph suggests that the first six points oscillate about the value of .267 whereas the remaining points average out to about 1.4/9 = .1555. Using these two levels for the two yields model the sum of the squared deviation are

$$\text{Error} = \sum_{i=1}^{6} (y_i - .267)^2 + \sum_{i=7}^{15} (y_i - 1.4/9)^2 = .113$$

Table 7.3.1 (a) Litton Band 4 Driver TWTs Bench Test Data

FRB	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
BNCH	0	0	0	1	0	0	0	0	0	1	1	1	0	1	1	1	1	0	2	1	0
N	2	3	1	1	1	1	1	1	3	1	1	4	2	2	1	3	2	1	4	3	2
Wks	56	57	67	75	77	80	81	81	82	84	87	88	88	105	106	108	109	111	114	115	117
Av. Wks	66.3							85.0					102.6					114.6			

FRB	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BNCH	0	0	0	0	0	1	2	1	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0
N	2	2	1	1	1	1	2	3	1	1	5	3	3	1	1	1	1	1	2	1	2	2	1	1
Wks	117	119	122	124	126	140	151	152	156	158	159	159	160	166	174	175	177	178	179	180	182	183	184	185
Av. Wks	128.6							156.5				164.9						181.5						

FRB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ETM	1	0	0	0	1	1	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0
N	2	1	3	1	3	4	3	2	1	1	2	3	2	1	1	1	1	1	2	2	3
Wks	186	188	189	191	192	193	194	195	198	199	204	211	214	215	217	217	220	224	225	226	227
Av. Wks	189.4					194.2				210.0						224.4					

FRB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BNCH	0	0	0	1	0	0	1	2	1	0	0	0	0	0	0	0	0	0
N	3	2	4	1	1	2	2	3	2	1	1	1	1	1	1	2	1	1
Wks	228	232	233	235	236	237	242	245	248	249	251	252	254	259	275	276	283	291
Av. Wks	231.5				241.9					266.6								

Legend: Wks = Shelf Life in Weeks of the TWTs in N
N = Sample Size for the Indicated Shelf Life
FRB = The Number of TWTs that Failed the FRB Screening
BNCH = The Number of TWTs that Failed the Bench Test after, 30 minute warm up
Av. Wks = The Average Shelf Life in Weeks per Group

AN/ALQ-131 DRIVER TWTs

Litton Band 4 TWTs Bench Test Results

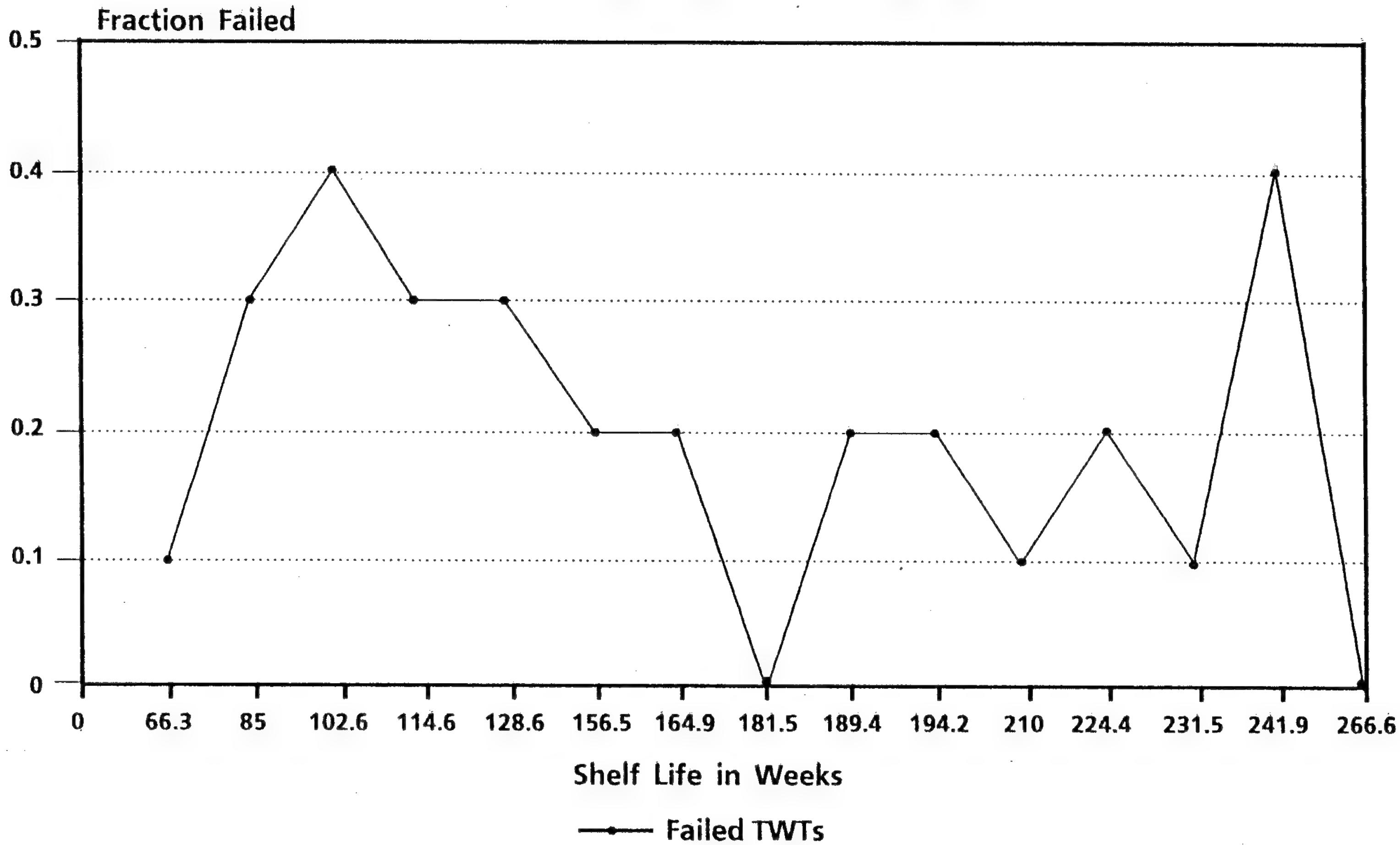


Figure 7.3.1 (a)

AN/ALQ-131 DRIVER TWTs

Litton Band 4 TWTs Bench Test Results

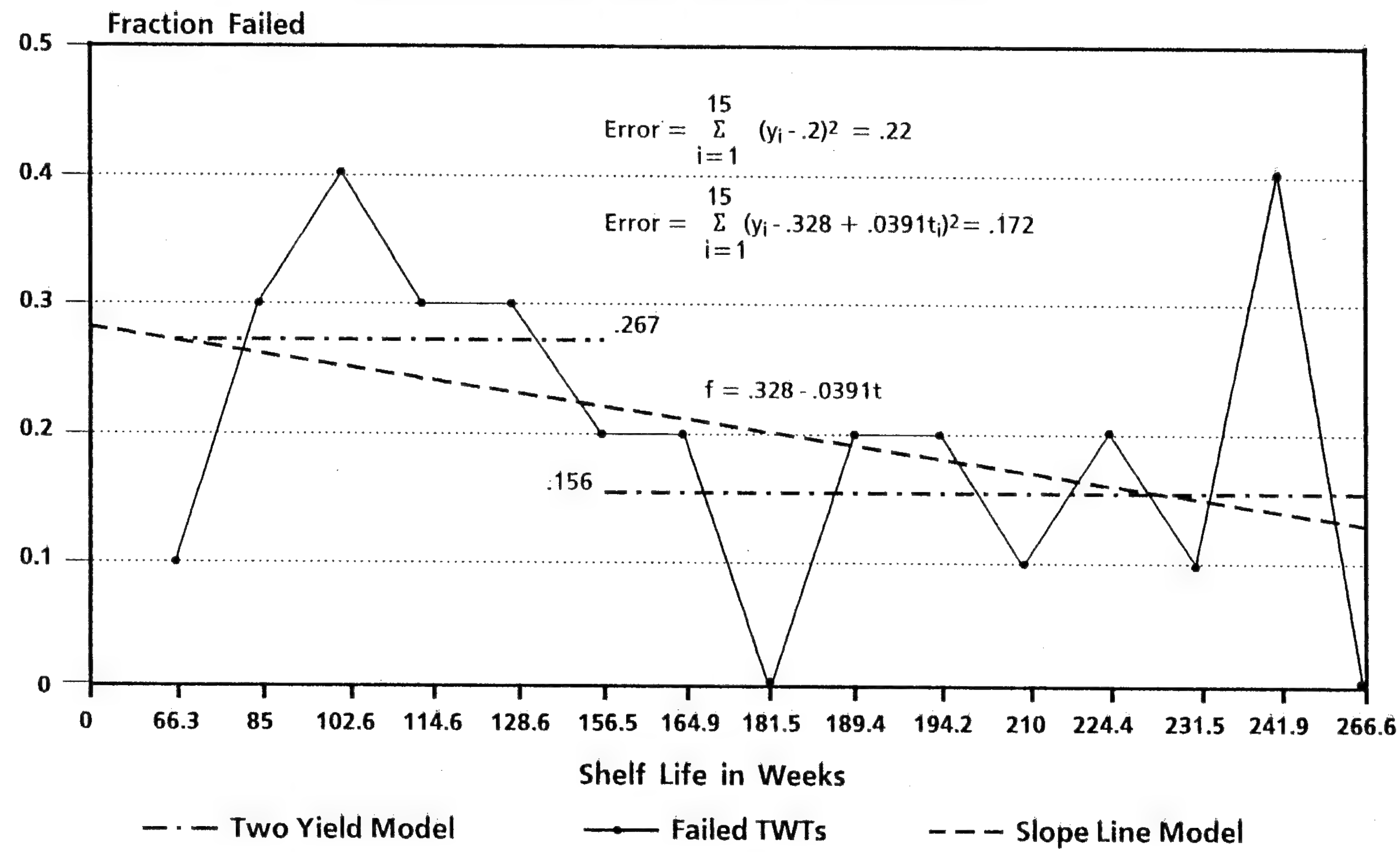


Figure 7.3.1 (b)

This shows quite clearly that the two yields model fits the data the best. Thus confirms the output TWTs results where the two yields model was also preferred. However, the band 4 TWTs have an average failure rate of 26.7% for the first three years and the earlier TWTs have a much better yield where the average failure rate is only about 15.6%.

7.3.2 Band 5 Litton TWTs

The band 5 TWTs basic data is presented in Table 7.3.2 (a). There were 300 tubes bench tested. The FRB screening has not been finished on them yet, therefore, no FRB failure analysis was undertaken on the partial results. For the analysis of the bench test failures, the data was partitioned into 15 groups of 20 samples per group. The plot of the fraction of failures per group are shown in Figure 7.3.2. (a). The first observation is that the level of failures is much higher than in the band 4 TWTs. Secondly, again there appears to be improvement in the yield of good tubes with age. To confirm this, a straight line, determined by the least squares fit approach, was computed for this data. It confirms the intuitive interpretation of the plot giving the following result

$$f = .9025 - .0389t \ ; \ t = \text{years}$$

Rather than take this result at its face value the previous successes of the two yields model makes us look closer at Figure 7.3.2 (b). Up to 3.5 years, the failure rate appears to be quite high. Then its average value drops significantly. The exact average for the first six points is $.858\bar{3}$ ($= 5.15/6$) and for the remaining nine points it is $.69\bar{4}$ ($= 6.25/9$). We take these two failure rates as a competitor to the sloped line model above. The sums of the squared deviations are then

$$\text{Error} = \sum_{i=1}^{6} (y_i - .858\bar{3})^2 + \sum_{i=7}^{15} (y_i - .69\bar{3})^2 = .259$$

$$\text{Error} = \sum_{i=1}^{15} (y_i - .9025 + .0389t_i)^2 = .326$$

Again the two yields model shown in Figure 7.3.2 (b), gives a better fit to the data than the sloped line as in all previous cases. The questions of deteriorating yield of the newer TWTs as well as the extremely high failure rates have to be addressed separately and outside the statistical analysis context.

Table 7.3.2 (a) Litton Band 5 Driver TWTs Bench Test Data

FRB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BNCH	0	1	1	1	2	2	4	5	5	12	2	10	1	1	1	3	4	3	3	3	0	1	5
N	1	1	2	1	2	3	4	6	6	12	2	10	1	1	1	3	4	3	3	4	1	1	8
Wks	46	69	73	78	79	95	96	100	101	104	105	105	106	112	126	127	128	128	129	130	135	142	145
Av. Wks	88.3								103.2			114.35						136.4					

FRB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BNCH	1	3	1	3	1	1	0	2	4	3	6	1	1	4	1	1	4	4	0	2	3	7	7	0	1
N	1	6	1	3	1	1	1	2	4	4	6	1	1	6	1	1	8	7	1	4	3	7	7	1	2
Wks	149	150	151	160	161	167	175	176	177	179	180	181	184	185	186	188	189	190	191	192	192	193	194	201	202
Av. Wks	167.15									182.25							190.0 5				194.5				

FRB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
BNCH	1	7	2	0	1	1	1	3	2	0	2	1	0	1	3	0	1	2	1	5	1	1	2	1	6	2	0	1
N	1	14	4	1	2	3	4	5	3	1	2	2	1	1	3	1	1	3	2	6	1	1	2	2	8	4	1	1
Wks	202	203	204	206	206	207	208	209	210	211	212	213	214	217	219	220	221	224	230	231	223	235	240	242	243	244	246	248
Av. Wks	203.3				208.75							223.65									242.3							

Legend: Wks = Shelf Life in Weeks of the TWTs in N
N = Sample Size for the Indicated Shelf Life
FRB = The Number of TWTs that Failed the FRB Screening
BNCH = The Number of TWTs that Failed the Bench Test after, 30 minute warm up
Av. Wks = The Average Shelf Life in Weeks per Group

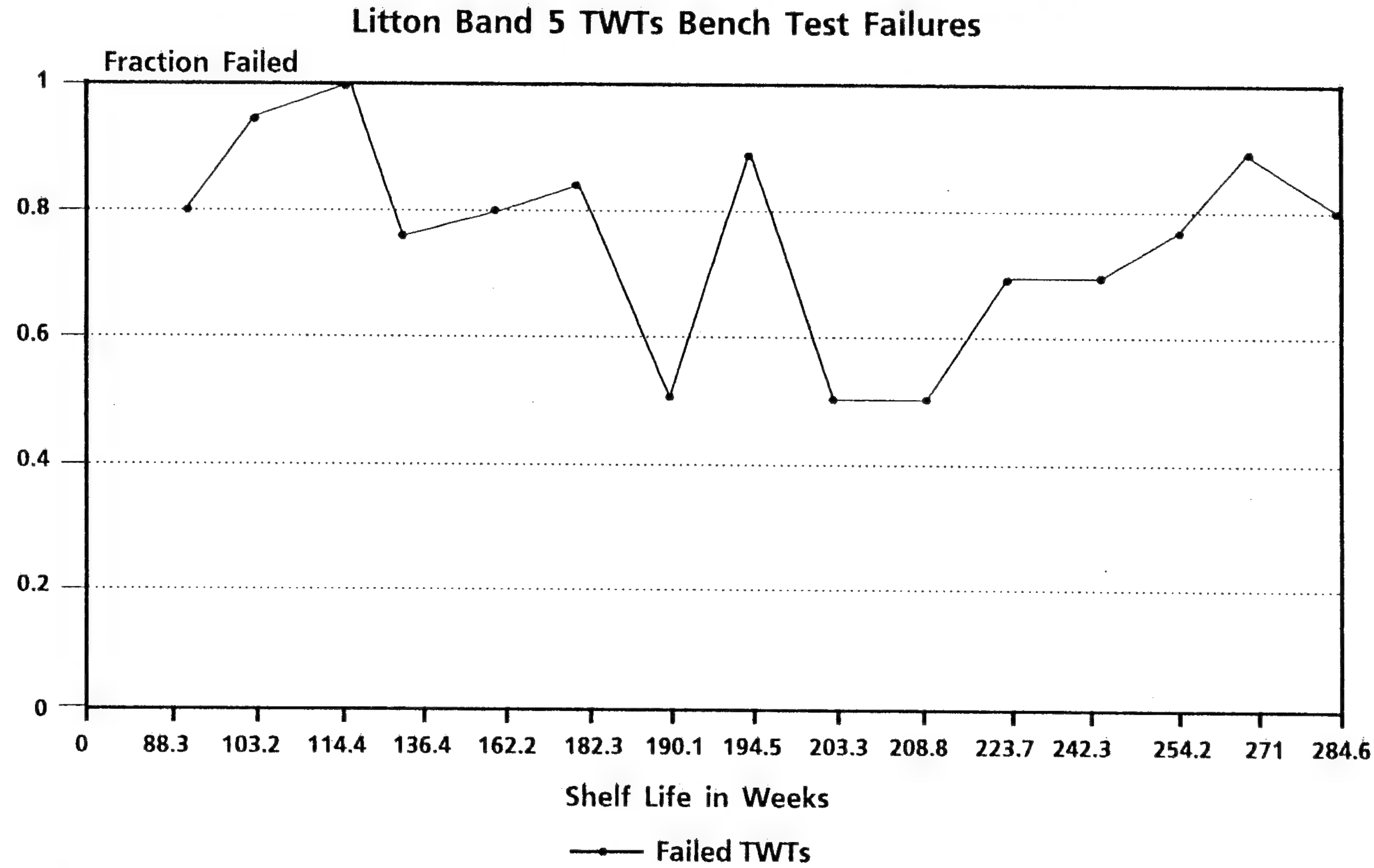
Table 7.3.2 (a) Litton Band 5 Driver TWTs Bench Test Data (cont'd.)

FRB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
BNCH	7	1	2	0	0	3	1	1	1	2	2	2	0	2	3	2	1	1	1	1	0
N	7	1	4	1	1	3	2	1	1	2	2	2	1	2	3	2	1	1	1	1	1
Wks	249	250	251	252	253	263	264	265	265	266	267	268	269	270	271	273	274	276	277	278	279
Av. Wks	254.2								270.45												

FRB	0	0	0	0	0	0	0	0	0	0
BNCH	1	4	3	1	1	2	1	2	0	1
N	1	4	3	2	1	3	1	3	1	1
Wks	279	280	281	282	283	284	285	286	303	305
Av. Wks	284.6									

Legend: Wks = Shelf Life in Weeks of the TWTs in N
N = Sample Size for the Indicated Shelf Life
FRB = The Number of TWTs that Failed the FRB Screening
BNCH = The Number of TWTs that Failed the Bench Test after, 30 minute warm up
Av. Wks = The Average Shelf Life in Weeks per Group

AN/ALQ-131 DRIVER TWTs

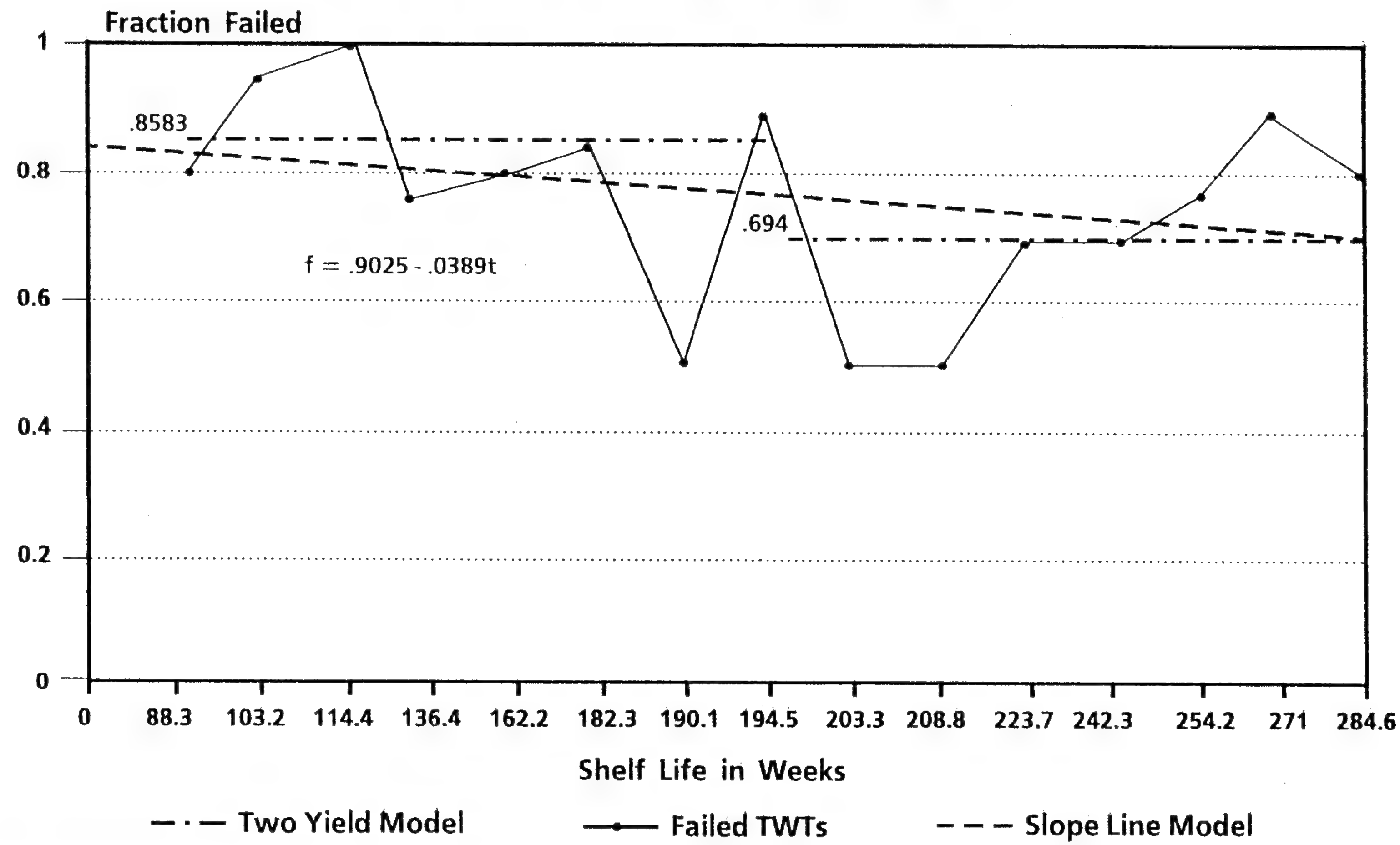


Each point represents a fraction of failed TWTs in a sample of 20

Figure 7.3.2 (a)

AN/ALQ-131 DRIVER TWTs

Litton Band 5 TWTs Bench Test Failures



Each point represents a fraction
of failed TWTs in a sample of 20

Figure 7.3.2 (b)

8.0 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Four important features of this task, which make it uniquely different from previous TWT investigations are:

1. A large sample of TWTs, of several types and from different vendors, was tested.
2. The tubes were built and stored over a long period of time.
3. The TWTs were tested on a TWT factory test tool.
4. AN/ALQ-131 system was available to confirm test results.

This combination allowed analyses and conclusions to be made that would not have been possible if the sample size and variety of tubes had been smaller.

This section addresses the following recommendations and conclusions:

1. System alignment procedures can be improved.
2. There is not a shelf life problem with output TWTs.
3. The driver TWT shelf life study must be completed before recommendations can be made.
4. Perveance problem should be investigated.
5. Minor repairs and re-optimization should be considered for a future screening effort.

8.1 Procedure Changes

8.1.1 ALQ-131 Band 3 Output TWT Grid Voltage Adjustment

The procedure used for adjusting the grid voltage (Ec) is to set it to the TWT label value while the High Voltage Power Supply (HVPS) is operating into a resistive load. This insures that the HVPS is operating and that the grid voltage is near its operating value before the HVPS is connected to the TWT. The next step is to connect the TWT to the HVPS and, if necessary, adjust the grid voltage (away from the resistive load setting) to obtain the label value collector current (Ib_2). The collector current adjustment is more important than the grid voltage adjustment. This adjustment is accomplished by entering the label value of the current into the support equipment computer. The computer has a programmed tolerance of plus or minus 20 milliamperes for Ib_2. If the grid voltage, as set on the resistive load, gives an Ib_2 current within the tolerance the computer will automatically pass to the next step. If the difference is greater than 20 mA, the computer will stop and direct the technician to adjust the grid voltage to bring the Ib_2 current into tolerance. The problem with this is that some tubes will not operate as well as they could with Ib_2 near the extreme limit of its tolerance. To improve this situation it was recommended that the Ib_2 tolerance be reduced from plus or minus 20 mA to plus or minus 5 mA. This tightening of the tolerance insures that the TWT will be optimally aligned. Changing the tolerance was a simple change and it was implemented in both the Block I and Block II systems.

8.1.2 System TWT Phase Shifter Adjustment Procedure

The only time a phase shifter adjustment should be made is when the TWT does not comply with system minimum power and helix current (i.e., no overloading) requirements. The phase shifter has been "factory adjusted" for specified performance and if it becomes necessary to readjust it the following guideline should be followed.

The phase shifter adjustment changes several parameters primarily power and helix current. Ideally the power would be set to meet it's requirement and the current would fall within it's specification. But this is often not the case. The adjustment must be repeated until both power and current are satisfactory and in some situations compromises must be made to achieve optimum performance.

To make and accurate phase shifter adjustment an HP8756C Scalar Network Analyzer or equivalent should be used. While making the adjustment the power should be monitored over the lower third of the bandwidth while observing the helix current. Adjust the phase shifter so that the output power just exceeds rated power. Check the helix current with RF drive applied at specified levels. If the it exceeds it's limit readjust the phase shifter to lower the current while maintaining rated power out. Figure 8.1.2 (a) illustrates a TWT that fails for low power out. Figure 8.1.2 (b) illustrates a marginally optimized TWT. Figure 8.1.2 (c) a properly optimized TWT.

8.2 Band 3 TWT Perveance Problem

The Varian Band 3 output TWT had a high failure rate caused by low collector 2 (Ib_2) current when the grid voltage was adjusted to label value. This is failure code 11 (Perveance). A total of 53 TWTs fell into this category (Appendix E).

The Ib_2 current was an average of 40 milliamperes below the label value which resulted in low gain and power output. An adjustment was made to change the grid voltage to obtain the label value Ib_2 current on the 53 TWTs. The grid voltage exceeded its specified value of 170 volts on 11 of the 53 TWTs. These tubes were declared unserviceable. Twenty-three of the 53 TWTs were returned as serviceable after it was determined that the grid voltage could be set to obtain the Ib_2 label current. The remaining 19 TWTs could not be made serviceable by adjusting Ib_2. The average grid label grid voltage of these TWTs was 139 volts, while the average grid voltage needed to obtain label Ib_2 current was 163 volts or a delta of 24 volts. This delta grid voltage indicates that the distance from the cathode to the grid had changed, or that the original label voltage was incorrect.

8.2.1 Perveance Recommendation

At system level the collector current is set by adjusting the grid voltage, and it is immaterial if the grid voltage is higher than the label value as long as it is within its specified limits. That is why 23 of the tubes could be returned as serviceable.

PHASE SHIFTER ADJUSTMENT

POOR OPTIMIZATION

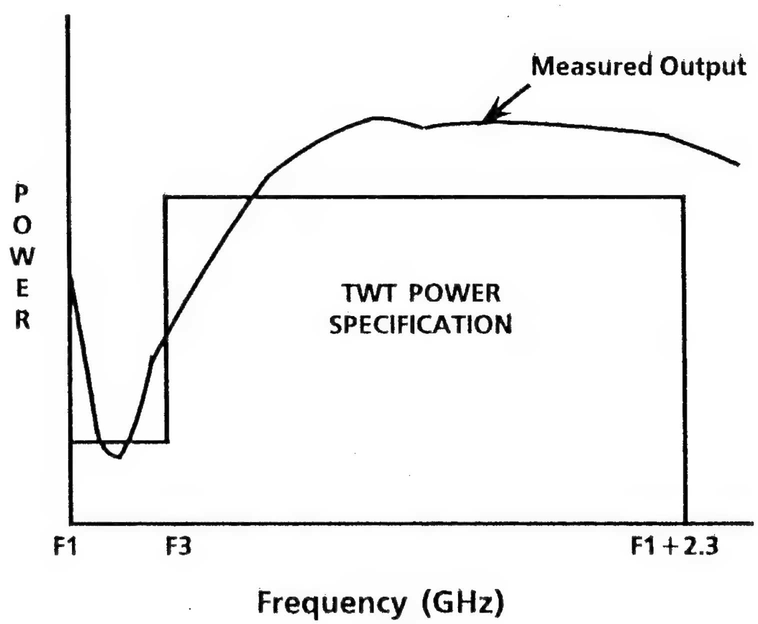


Figure 8.1.2 (a)

MARGINAL OPTIMIZATION

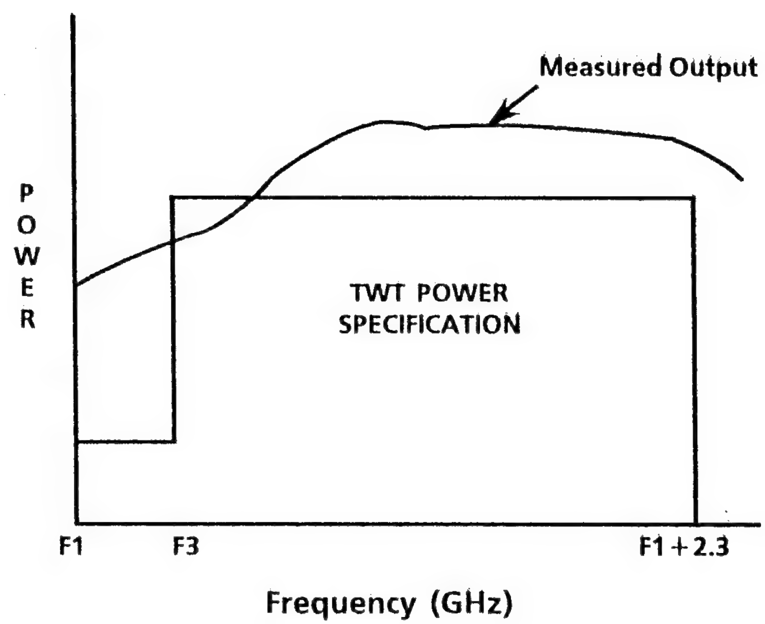


Figure 8.1.2 (b)

PHASE SHIFTER ADJUSTMENT

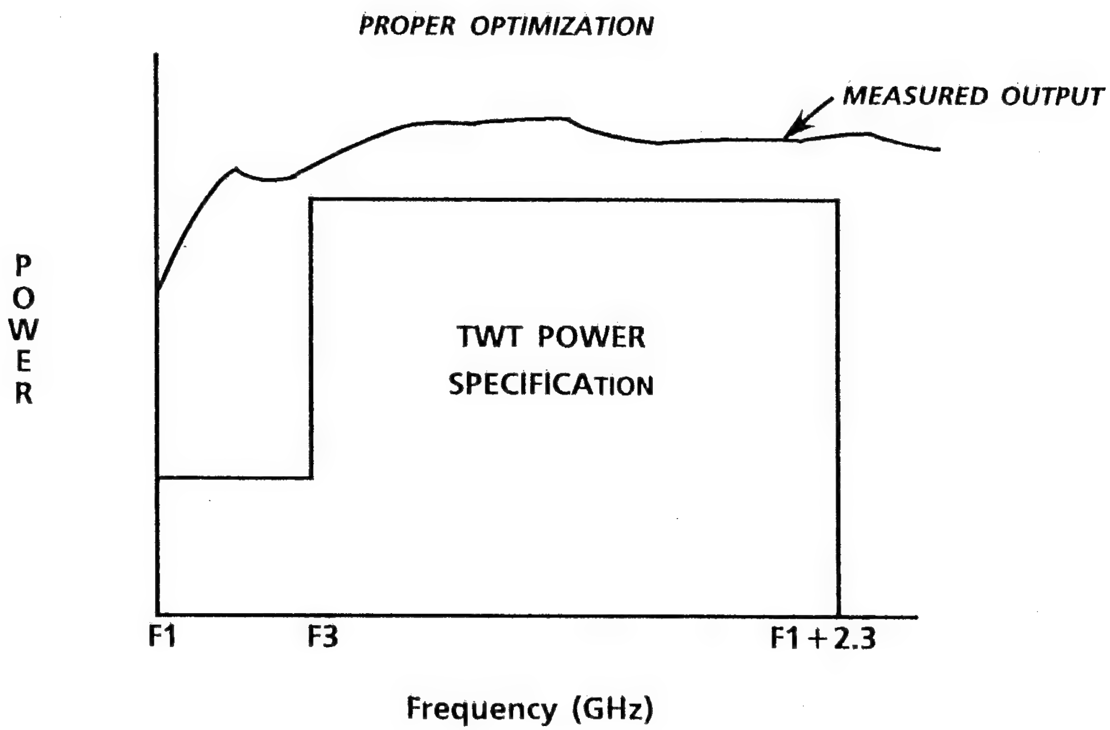


Figure 8.1.2 (C)

The important thing is to understand why there is an excessive difference between the label value of grid voltage and the actual voltage needed top obtain the correct Ib_2 current. Is it a symptom of a change in the gun of the tube or a manufacturing process? An analysis is required to resolve this issue, and it is recommended that Varian be tasked to perform it.

8.3 Minor Repairs and Re-Optimization

The primary purpose of this effort, to screen large quantities of TWTs and return as many serviceable tubes to the user as possible, was accomplished. But even more tubes could have been made serviceable if minor repairs had been initiated and tubes re-optimized. This was not possible because of the urgency of the situation and the task definition.

Minor repairs are defined as simple mechanical replacements such as replacing a bad thermostat, a cracked coaxial hardline, a damaged low voltage connector, or a defective phase shifter.

Re-optimization consists of making equalizer adjustments or making new voltage labels. Several tubes failed to meet the specified requirements when the voltages were set to the label values. By setting the voltages to slightly different values, (but still within TWT specifications) the tubes could be optimized to meet all specifications. For example, if minor repairs and re-optimization had been performed during this task, a minimum of 76 tubes could have been returned as serviceable.

It is recommended that minor repairs and re-optimization be considered for future screening efforts; but more importantly, it is recommended that the TWT vendor's manufacturing procedures be reviewed to determine if improvements can be made to eliminate the need for minor repairs and re-optimization.

8.4 Driver TWT Slow Warm-Up Problem

Litton Band 5 drivers failed to meet the first stage gain requirement three minutes after turn-on. Out of 300 tubes, 24 met the gain requirement after 3 minutes and 84 met it after 30 minutes of on time. Litton Band 4 drivers exhibited the same problem, but to a lesser degree.

8.4.1 Problem Description

The problem of slow warm-up or low gain has been previously analyzed by Litton. The second stage does not exhibit as great a warm-up problem as the first stage. The basic difference between the two stages is that the diameter of the first stage cathode is smaller than that of the second stage. The smaller diameter cathode is needed to meet the first stage noise figure requirements, but its size is more sensitive to residual gasses during non-operating periods and degraded cathode emission or low gain results.

After sufficient burn-in the cathode can recover and satisfactory operation is possible. Litton recommended several design changes that could be incorporated into new drivers to improve the warm-up time and a periodic burn-in procedure that could be implemented for all Band 5 drivers. The only practical solution for the existing tubes is to implement a burn-in procedure.

8.4.2 Driver Burn-In Program

As a result of the test effort and Litton's analysis, two questions needed to be answered before the tubes could be declared serviceable: what was a sufficient burn-in time, and how long after sufficient burn-in would the tubes remain operational if they were held in storage? To answer these questions a program was started to burn-in four groups of TWTs for 1, 6, 18, and 36 hours respectfully. After burn-in, the tubes would be put in storage and portions of each group removed and tested on a monthly schedule from one to six months. Six months corresponds to the PMI cycle. This program started in December 1990 and will end in June of 1991. The results will be published in an addendum of this report. Table 8.4.2 (a) shows the Driver TWT Burn-In/Test Plan.

8.4.3 Driver TWT Considerations

The driver TWT slow warm-up problem presents two areas of concern. The first is why aren't more field failures reported? The answer to this may be that in the field the drivers are burned-in longer than specified and periodically turned on enough times to prevent the problem from being noted. After the specified warm-up time, the gain of many tubes was out of specification by only a few dB. Because of the tolerances involved and system margins, many systems could tolerate this condition and perform satisfactorily. As time went on, the gain would increase until it was in specification and the system would then perform at nominal values. If the driver did cause a failure, the chances are that the test would be repeated to confirm the failure. Repeating the test would increase the burn-in time. The gain would increase with time and the test would probably pass on the second attempt.

The second area of concern was how the driver TWT data could be used with output TWT data to present an overall picture. Because of the magnitude of the warm-up problem, it was decided to separate the results. Therefore, the shelf life analysis is based on only driver tubes. There is additional justification for this separation in that the driver TWT consists of two low power stages and a self contained HVPS while the output TWT consists of one high power stage which uses an external power supply.

Band 5 Litton Driver TWTs*
Shelf Life Study

Month	Group 1 (Note-1)	Group 2 (Note-2)	Group 3 (Note-3)	Group 4 (Note-4)
Initial	#1-8	#9-16	#17-24	#25-32
1	#1, 2	#9, 10	#17, 18	#25,26
2	#1, 2, 3	#9, 10, 11	#17, 18, 19	#25, 26, 27
3	#1, 2, 4	#9, 10, 12	#17, 18, 20	#25, 26, 28
4	#1, 2, 5	#9, 10, 13	#17, 18, 21	#25, 26, 29
5	#1, 2, 6	#9, 10, 14	#17, 18, 22	#25, 26, 30
6	#1-8	#9-16	#17-24	#25-32

Table 8.4.2 (a)

* Each TWT number corresponds to a particular serial number

Note-1 Group 1 Driver TWTs were initially burned-in for one hour

Note-2 Group 2 Driver TWTs were initially burned-in for six hours

Note-3 Group 3 Driver TWTs were initially burned-in for eighteen hours

Note-4 Group 4 Driver TWTs were initially burned-in for thirty-six hours

8.5 Output TWT Shelf Life

A product of the testing was the analysis of failure rate as a function of storage time. Over 380 new TWTs built between 1983 and 1990, by different vendors, were purchased by the government as spares and held in storage. The tubes in the original sealed containers were removed from stores and taken to the test facility where the seals were broken and the tubes tested.

The statistical analysis performed on the resulting data provides some insight into the question of shelf life. The analysis was based on the results obtained from testing only new TWTs. TWTs used in the field and returned to the depot were also tested, but because it was not possible to determine the storage time or when the TWT was last operated, the results were not used in the shelf life analysis.

The major conclusions of the analysis are:

1. The failure rate is not a function of time.
2. Vacuum leakage is not a problem.
3. TWT burn-in is important, but tubes need not be removed from storage specifically to be burned in and returned to storage. TWTs must be burned-in before use.

These conclusions are addressed in the following paragraphs.

8.5.1 Failure Rate

Figure 6.3.5 (d) shows failure rate plotted against storage time. The dominant feature is that the failure rate is not a function of time. From zero to four years of storage, the rate is a constant 16%. From four to seven the rate is a constant 25%. Appendix B, pages B-113 through B-117 shows that the failure modes that occur in the later years are the same modes that occur in the earlier years. Tubes that failed because of going down to air (DTA) or being gassy do not appear in significant numbers. Of all the tubes tested, none went down to air and only seven failed because they were gassy. It was expected that the failures due to leakage would increase with time, but the data does not support this. Appendix B, page B-108 shows the distribution of gassy tubes.

The time covered by the analysis starts from the time indicated by the date code on the TWT label and the time when the tube was tested. Zero time is the date code and the end time is the test time. What happens to the TWT from the time the date code was stamped into the label and the time the tube was placed on the depot shelf is unknown. Obviously it was tested, packed and shipped within a short period of time since the newest test TWT tested was only four weeks old. It is not probable that the detected failures were caused by packing and shipping. So the question to be answered is what happened or existed from time zero to four weeks that caused the failures to occur.

8.5.2 Vacuum Leakage

Vacuum leakage occurs when the gas pressure in the vacuum envelope increases. The increase in pressure can be caused either by real or virtual leaks. A real leak is gas leaking into the vacuum from the outside and a virtual leak is gas being generated from a source within the vacuum. Both can be corrected by proper selection of material, good mechanical design, controlled processes, and eliminating gas traps. The low number of leakage failures indicates that the vendors have implemented the design and manufacturing practices that significantly reduce leakage. This does not mean that the industry should not continue to improve cathode design or add getters to further reduce the effects of residual gasses. For this testing effort, leakage was not found to be a problem.

8.5.3 Holding Period

It has been suggested that tubes be held at a TWT vendor's facility for an extended period before an ATP is performed. This would in theory catch time dependent failures such as leaks. The test results indicate a holding period is not required if its purpose is to find time dependent faults. The probability is that if a vendor held a group of TWTs for a period of time and retested them, the failure rate would be similar to the constant failure rate found in this task, and the variety of failures would be the same.

8.5.4 Burn-In For Tubes Held In Storage

Burn-in is a procedure used to reduce the pressure in the vacuum caused by possible leakage. Basically the filament warm up time is extended and gasses are burned off (absorbed in the cathode).

All of the tubes in this task were removed from stores, burned in per the prescribed procedure and tested. Eighty-four percent of the tubes held in storage for up to four years and 75% of the tubes held from four to seven years passed. If the tubes were gassy, burn-in corrected the problem.

8.5.5 Depot Storage Procedures

Since there is a constant failure rate for the first four years of storage, it is immaterial if a first-in-first-out (FIFO) or last-in-first-out (LIFO) procedure is used. If the tubes were sent directly to the user or held in storage the failure rate would be the same. For the later years, the rate is also constant, but higher. Intuitively, one feels that a TWT stored for 7 years would have a higher failure rate than one stored for one year. Since there is no data for tubes held longer than 7 years, it is not possible to emphatically state that tubes stored for ten years will not exhibit time-dependent failure. A FIFO policy would lessen this possibility provided the first in went out in less than ten years. In addition, handling problems and the probability of something else going wrong would be reduced.

8.6 Output TWT - Failure Rate Conclusions

The unique feature of the failure rates is that it has two constant levels. Sixteen percent of the tubes less than four years old and 25% of the tubes greater than four years old taken directly from the original packing containers may fail. Because this testing effort encompassed a large number of TWTs built and stored over a seven-year span the data can be interpreted differently than data randomly accumulated or obtained from testing a small number of TWTs built and stored in the same time period. If TWTs built in 1987 were tested in 1990 and a 16% failure rate occurred, and no other data was available, a possible explanation of the data would be that something happened to the tubes between 1987 and 1990 and the failure rate was a function of time. A benefit of this effort was to find that tubes stored for months failed at the same rate as tubes stored for years.

Another benefit was that the TWTs were tested in a laboratory environment by skilled engineers using test equipment similar to the equipment used by TWT vendors to perform ATPs. The AN/ALQ-131 system, support equipment and HVPS were not used for ATPs. In specific cases the system was used to confirm or clarify the data taken at bench level. No failures occurred at system level test provided the tube passed the ATP. Tubes were only tested on the system after the ATP was run. Therefore, the argument that the system or system HVPS could have stressed the TWT and caused the failure is not valid and the data is not tainted by the possibility of system interaction.

The problem that this effort highlights is the constant failure rate of tubes removed directly from the original containers. This may be a manufacturing procedure problem, not a shelf life problem. Hopefully, as a result of this report the organizations interested in TWT quality will address the actions needed to reduce the failure rate. If this rate was reduced, the logistics aspects of TWT procurement would improve.

The data shows that the failure rate of older tubes is higher than that of newer tubes; but, as stated before, there is not a time dependent function that can be assigned to the difference. The reason for the difference may be that the quality of TWTs has improved over what it was five to seven years ago. This is not an unreasonable assumption in that the government has continually raised its reliability standards. But, if failures are to be further reduced, the TWT industry must continue the process of quality improvement.

AN/ALQ-131 BLOCK I Band 3 LITTON Output TWTs

Part Number .... 583R679H01 *
Stock Number 5960-01-040-4440EW
New TWT .... No

Vendor .... LITTON
Band 3
Block I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
1.	3251	8619	FAIL	2, 12	PASS	AA
2.	3271	8629	FAIL	5		FF
3.	3282	8630	FAIL	11, 12	PASS	FF
4.	3287	8634	FAIL	2, 12	FAIL	FF
5.	3358	8742	FAIL	2, 12	FAIL	FF
6.	40134A	7915	FAIL	4, 2	FAIL	FF
7.	40304B	8003	FAIL	2, 4	FAIL	FF
8.	40336C	8108	FAIL	6	PASS	FF
9.	40344A	8401	FAIL	6, 4, 2	PASS	FF
10.	40352C	8541	FAIL	6, 2	FAIL	FF
11.	40360C	8118	FAIL	6, 2 ,4	FAIL	FF
12.	40361D	8120	FAIL	2, 4	FAIL	FF
13.	40364A	8003	FAIL	6, 2	PASS	FF
14.	40374C	8125	FAIL	2, 4	PASS	FF
15.	40382C	8130	FAIL	2, 11	PASS	AA
16.	40543D	8216	FAIL	10, 2, 12	FAIL	FF
17.	40553D	8221	FAIL	6, 4	FAIL	FF
18.	40573D	8234	FAIL	8		FF
19.	40581D	8240	PASS		PASS	AA
20.	40684D	8215	FAIL	11, 2, 12	FAIL	FF

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 LITTON Output TWTs

Part Number	583R679H01 *	Vendor	LITTON
Stock Number	5960-01-040-4440EW	Band	3
New TWT	No	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code*	System Test Results	TWT Status**
21.	40711D	8542	FAIL	4, 2	FAIL	FF
22.	40773D	8734	FAIL	4		FF
23.	43020C	8120	FAIL	10		FF
24.	43040D	8607	FAIL	2	PASS	FF
25.	43064D	8401	FAIL	2, 4	PASS	FF
26.	43081D	8211	FAIL	11, 2, 4	PASS	AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 VARIAN Output TWTs

Part Number	583R679H03 *	Vendor	VARIAN
Stock Number	5960-01-069-8028EW	Band	3
New TWT	No	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
1.	0101	9999	FAIL	2, 10		FF
2.	0106	8221	FAIL	11, 2, 4		FF
3.	0115	9999	PASS			AA
4.	0118	8150	FAIL	2, 4, 11		FF
5.	0125	8239	FAIL	4, 2, 3	FAIL	FF
6.	0128	8243	FAIL	2		FF
7.	0129	8243	FAIL	11, 2, 12		FF
8.	0133	8243	FAIL	11, 2, 4		FF
9.	0135	8243	FAIL	2, 4		FF
10.	0137	8247	FAIL	7		FF
11.	0146	8252	FAIL	11, 2, 12	FAIL	FF
12.	0154	8313	FAIL	2, 4		FF
13.	0165	8317	FAIL	2		FF
14.	0190	9999	FAIL	2, 12		AA
15.	0192	8150	PASS			AA
16.	0208	9999	PASS			AA
17.	0212	8150	PASS			AA
18.	0217	8150	PASS			AA
19.	0220	9999	FAIL	11, 12		FF
20.	0226	9999	FAIL	11, 4, 2		FF

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 VARIAN Output TWTs

Part Number .... 583R679H03 *
Stock Number 5960-01-069-8028EW
New TWT .... No

Vendor .... VARIAN
Band 3
Block I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
21.	0228	9999	FAIL	11, 2		FF
22.	0229	9999	PASS			AA
23.	0232	9999	PASS			AA
24.	0233	8150	FAIL	7, 10, 12		FF
25.	0236	9999	PASS			AA
26.	0238	9999	FAIL	11, 2		FF
27.	0240	8150	PASS		PASS	AA
28.	0247	9999	FAIL	11, 12		AA
29.	0268	9999	FAIL	11, 2		FF
30.	0272	9999	PASS			AA
31.	0275	9999	FAIL	11, 2		FF
32.	0280	9999	FAIL	8, 11		FF
33.	0285	9999	FAIL	11, 12		AA
34.	0287	8150	FAIL	11, 12		AA
35.	0288	9999	FAIL	11, 12		AA
36.	0290	8352	FAIL	8		FF
37.	0297	8352	FAIL	11, 2	PASS	FF
38.	0306	8404	PASS			AA
39.	0309	8404	PASS			AA
40.	0313	8404	FAIL	11, 2		FF

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 VARIAN Output TWTs

Part Number	583R679H03 *	Vendor	VARIAN
Stock Number	5960-01-069-8028EW	Band	3
New TWT	No	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
41.	0314	8404	PASS			AA
42.	0328	8408	PASS			AA
43.	0331	8408	FAIL	11, 12		FF
44.	0336	8408	FAIL	11, 12		AA
45.	0339	8408	PASS			AA
46.	0341	8408	FAIL	11, 2, 12		FF
47.	0347	8413	FAIL	8		FF
48.	0352	8413	PASS			AA
49.	0354	8413	FAIL	7, 6		FF
50.	0356	8413	PASS			AA
51.	0366	8413	FAIL	11, 12	PASS	AA
52.	0367	8413	FAIL	11, 12		AA
53.	0373	8417	FAIL	11, 2		FF
54.	0374	8417	PASS			AA
55.	0383	8421	FAIL	11, 12		AA
56.	0386	8421	FAIL	11, 2		FF
57.	0394	8426	PASS			AA
58.	0399	8426	FAIL	8, 11		FF
59.	0400	8426	FAIL	11, 12		AA
60.	0401	8426	FAIL	11, 2	PASS	AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 VARIAN Output TWTs

Part Number	583R679H03 *	Vendor	VARIAN
Stock Number	5960-01-069-8028EW	Band	3
New TWT	No	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
61.	0402	8426	FAIL	11, 2	FAIL	FF
62.	0404	8426	FAIL	11, 12		AA
63.	0414	8434	FAIL	11, 12		AA
64.	0425	8434	PASS			AA
65.	0426	8434	FAIL	11, 12		AA
66.	0429	8439	PASS			AA
67.	0430	8439	FAIL	11, 12		AA
68.	0431	8439	FAIL	8		FF
69.	0433	8439	PASS			AA
70.	0439	8439	FAIL	11, 12		AA
71.	0440	8439	PASS			AA
72.	0454	8443	FAIL	11, 12	PASS	AA
73.	0455	8443	PASS			AA
74.	0461	8443	PASS			AA
75.	0466	8447	FAIL	11, 12		AA
76.	0468	8447	PASS		PASS	AA
77.	0470	8447	FAIL	2, 10, 6		FF
78.	0472	8447	PASS			AA
79.	0481	8452	FAIL	8		FF
80.	0485	8452	FAIL	11, 2, 4		FF

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 VARIAN Output TWTs

Part Number	583R679H03 *	Vendor	VARIAN
Stock Number	5960-01-069-8028EW	Band	3
New TWT	No	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
81.	0487	8504	FAIL	2		FF
82.	0494	8504	FAIL	11, 12	PASS	AA
83.	0496	8504	PASS			AA
84.	0501	8504	PASS			AA
85.	45006	8039	FAIL	11, 6		FF
86.	45007	8126	FAIL	2, 12		AA
87.	45008	8044	FAIL	7		FF
88.	45011	8044	FAIL	11, 12		AA
89.	45017R	8513	FAIL	11, 12		FF
90.	45047	9999	FAIL	8, 11		FF
91.	45048	9999	FAIL	8, 11		FF
92.	45052	8243	FAIL	11, 12		AA
93.	45059	8352	FAIL	11, 12		AA
94.	45061	8352	FAIL	2		FF
95.	45064	8404	FAIL	10, 2	PASS	AA
96.	48007R	8521	PASS			AA
97.	48011	8104	FAIL	11, 2	FAIL	FF
98.	48015	8513	FAIL	2		FF
99.	48017	8030	FAIL	11, 7		FF
100.	48018	8030	FAIL	6, 2		FF

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 VARIAN Output TWTs

Part Number	583R679H03 *	Vendor	VARIAN
Stock Number	5960-01-069-8028EW	Band	3
New TWT	No	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
101.	48022	8130	FAIL	6	FAIL	FF
102.	48028	8021	FAIL	11, 12	PASS	AA
103.	48054	8113	FAIL	6		FF
104.	48069	8121	FAIL	4, 2		FF
105.	48070	8121	FAIL	11, 2		FF
106.	48071	8121	FAIL	11, 2		FF
107.	48077	8126	PASS			AA
108.	48079	8126	FAIL	11, 2, 3		FF
109.	48084	8130	FAIL	4		FF
110.	48086	8204	FAIL	5		FF
111.	48102	8130	FAIL	11, 2		FF
112.	48104R	8521	PASS			AA
113.	48107	8130	FAIL	2, 12, 10		FF
114.	48109	8134	PASS			AA
115.	48111	8134	PASS			AA
116.	48166	9999	PASS			AA
117.	48169	9999	FAIL	5		FF
118.	48186	9999	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 TMEC Output TWTs

Part Number	583R679H04*	Vendor	TMEC
Stock Number	5960-01-299-5832EW	Band	3
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
1.	0010	8724	PASS			AA
2.	0012	8726	PASS			AA
3.	0013	8726	FAIL	3, 12		FF
4.	0018	8728	PASS			AA
5.	0020	8728	PASS			AA
6.	0024	8731	PASS			AA
7.	0031	8732	PASS		PASS	AA
8.	0038	8733	PASS			AA
9.	0048	8736	PASS			AA
10.	0049	8736	PASS			AA
11.	0172	8751	PASS			AA
12.	0192	8801	PASS			AA
13.	0195	8804	PASS			AA
14.	0202	8804	PASS			AA
15.	0296	8814	FAIL	10, 12		FF
16.	0297	8814	PASS		PASS	AA
17.	0298	8814	PASS		PASS	AA
18.	0299	8814	PASS		PASS	AA
19.	0303	8815	PASS		PASS	AA
20.	0310	8816	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 TMEC Output TWTs

Part Number	583R679H04*	Vendor ...	TMEC
Stock Number	5960-01-299-5832EW	Band	3
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
21.	0313	8817	PASS			AA
22.	0331	8819	PASS			AA
23.	0332	8819	PASS			AA
24.	0337	8820	PASS			AA
25.	0338	8820	PASS			AA
26.	0341	8820	PASS			AA
27.	0342	8820	PASS			AA
28.	0345	8820	FAIL	2, 10, 12		FF
29.	0348	8821	PASS			AA
30.	0349	8821	FAIL	2, 10, 12		AA
31.	0350	8821	PASS	1		AA
32.	0356	8822	FAIL	2, 3, 12	FAIL	FF
33.	0358	8824	PASS		PASS	AA
34.	0359	8824	PASS			AA
35.	0360	8824	PASS			AA
36.	0361	8824	PASS			AA
37.	0362	8824	PASS			AA
38.	0363	8824	PASS			AA
39.	0372	8845	PASS		PASS	AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 VARIAN Output TWTs

Part Number	583R821H02*	Vendor	VARIAN
Stock Number	5960-01-040-4442EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
1.	05004	8530	PASS			AA
2.	05006	8534	PASS			AA
3.	2K011	8308	PASS			AA
4.	2K019	8308	PASS	1	PASS	AA
5.	3A016	8308	PASS			AA
6.	3B001	8313	PASS			AA
7.	3B003	8313	FAIL	6	PASS	AA
8.	3B007	8313	FAIL	3, 12		AA
9.	3C028	8330	FAIL	10, 12		FF
10.	3E014	8330	FAIL	7		FF
11.	3E027	8330	PASS			AA
12.	3F002	8330	PASS			AA
13.	3F005	8330	PASS			AA
14.	3F010	8330	PASS			AA
15.	3F013	8330	PASS			AA
16.	3F015	8330	PASS			AA
17.	3F017	8330	PASS			AA
18.	3F020	8330	FAIL	10, 12		FF
19.	3G004	8343	FAIL	7, 12		FF
20.	3G009	8343	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 VARIAN Output TWTs

Part Number	583R821H02*	Vendor	VARIAN
Stock Number	5960-01-040-4442EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
21.	3H015	8339	PASS	1		AA
22.	4A007	8408	PASS			AA
23.	58086R	8526	PASS		PASS	AA
24.	5C011	8608	FAIL	7, 6, 12	FAIL	FF
25.	5C015	8539	PASS			AA
26.	5C019	8534	PASS			AA
27.	5C033	8534	FAIL	5		FF
28.	5E002	8539	PASS			AA
29.	5E010	8610	PASS			AA
30.	5F006	8543	PASS			AA
31.	5F008	8534	FAIL	7, 2		FF
32.	5F011	8534	PASS			AA
33.	5F020	8539	FAIL	10		FF
34.	5G001	8613	FAIL	2, 12	PASS	AA
35.	5G004	8626	PASS			AA
36.	5G009	8608	PASS			AA
37.	5G010	8543	PASS			AA
38.	5G012	8539	FAIL	8, 5		FF
39.	5G014	8539	PASS			AA
40.	5G016	8539	FAIL	5		FF

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 VARIAN Output TWTs

Part Number	583R821H02*	Vendor	VARIAN
Stock Number	5960-01-040-4442EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
41.	5G021	8534	PASS			AA
42.	5G023	8539	PASS			AA
43.	5G027	8539	PASS			AA
44.	5G029	8547	PASS			AA
45.	5G034	8539	PASS			AA
46.	5H001	8539	FAIL	5		FF
47.	5H005	8608	PASS			AA
48.	5H010	8539	PASS			AA
49.	5H011	8543	PASS			AA
50.	5H012	8543	PASS			AA
51.	5H013	8613	PASS	1		AA
52.	5J004	8608	PASS			AA
53.	5J007	8543	PASS	1	PASS	AA
54.	5J009	8543	PASS			AA
55.	5J010	8543	FAIL	9	PASS	FF
56.	5J011	8543	PASS			AA
57.	5J015	8543	FAIL	7, 10		FF
58.	5J022	8543	PASS			AA
59.	5J025	8547	PASS		PASS	AA
60.	5J026	8543	FAIL	10, 12		FF

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 VARIAN Output TWTs

Part Number	583R821H02 *	Vendor	VARIAN
Stock Number	5960-01-040-4442EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
61.	5K017	8552	PASS			AA
62.	5K031	8543	PASS			AA
63.	5K036	8543	PASS	1	PASS	AA
64.	5L002	8552	PASS			AA
65.	5L008	8552	PASS			AA
66.	5L010	8552	PASS			AA
67.	5L013	8552	FAIL	8		FF
68.	5L015	8552	PASS			AA
69.	5L018	8552	FAIL	9		FF
70.	5L019	8604	PASS			AA
71.	5L020	8617	FAIL	6		AA
72.	5L038	8608	PASS			AA
73.	5M004	8608	PASS			AA
74.	5M006	8608	PASS			AA
75.	6A001	8604	FAIL	2, 12		FF
76.	6A002	8608	FAIL	10, 12		FF
77.	6A003	8613	PASS			AA
78.	6A004	8608	PASS			AA
79.	6A005	8608	PASS			AA
80.	6A006	8608	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 VARIAN Output TWTs

Part Number	583R821H02 *	Vendor	VARIAN
Stock Number	5960-01-040-4442EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code*	System Test Results	TWT Status**
81.	6A009	8604	PASS	1	PASS	AA
82.	6A011	8608	PASS			AA
83.	6A012	8608	FAIL	10, 12	FAIL	FF
84.	6A013	8608	PASS			AA
85.	6A015	8608	FAIL	5		FF
86.	6A016	8608	PASS			AA
87.	6A018	8608	PASS			AA
88.	6A019	8613	PASS			AA
89.	6A022	8608	PASS			AA
90.	6A025	8608	PASS			AA
91.	6A026	8630	PASS	1		AA
92.	6A028	8613	PASS			AA
93.	6A030	8613	FAIL	5		FF
94.	6A032	8613	PASS			AA
95.	6A033	8608	PASS			AA
96.	6A036	8613	PASS			AA
97.	6A040	8631	PASS	1	PASS	AA
98.	6A045	8613	PASS			AA
99.	6A046	8613	PASS	1		AA
100.	6B001	8613	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 VARIAN Output TWTs

Part Number	583R821H02 *	Vendor	VARIAN
Stock Number	5960-01-040-4442EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
101.	6B004	8617	PASS			AA
102.	6B005	8626	FAIL	2, 12		AA
103.	6B007	8613	FAIL	2, 12	PASS	AA
104.	6C005	8617	PASS			AA
105.	6C009	8617	PASS			AA
106.	6C012	8617	PASS			AA
107.	6C014	8617	PASS			AA
108.	6C015	8617	PASS			AA
109.	6C018	8617	PASS			AA
110.	6C023	8617	PASS			AA
111.	6C026	8621	FAIL	8		FF
112.	6C027	8639	PASS			AA
113.	6C029	8617	PASS			AA
114.	6C030	8617	PASS			AA
115.	6C033	8626	PASS			AA
116.	6D003	8621	PASS			AA
117.	6D013	8626	PASS			AA
118.	6D014	8621	PASS			AA
119.	6D017	8621	PASS			AA
120.	6D020	8621	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 VARIAN Output TWTs

Part Number	583R821H02 *	Vendor	VARIAN
Stock Number	5960-01-040-4442ew	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
121.	6D022	8626	PASS			AA
122.	6D025	8626	PASS			AA
123.	6D027	8626	PASS			AA
124.	6D028	8626	PASS			AA
125.	6E016	8639	PASS			AA
126.	6E017	8630	PASS			AA
127.	6E019	8630	PASS			AA
128.	6F004	8639	PASS			AA
129.	6F005	8630	FAIL	3, 12	FAIL	FF
130.	6F006	8630	PASS			AA
131.	6F009	8630	PASS			AA
132.	6F013	8643	FAIL	2, 3, 12	FAIL	FF
133.	6F016	8634	PASS			AA
134.	6F018	8634	PASS			AA
135.	6F021	8634	PASS			AA
136.	6F027	8634	PASS			AA
137.	6F029	8634	PASS			AA
138.	6F030	8643	FAIL	2, 12	FAIL	FF
139.	6F031	8634	PASS			AA
140.	6G001	8639	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 VARIAN Output TWTs

Part Number .... 583R821H02 *
Stock Number 5960-01-040-4442EW
New TWT .... Yes

Vendor ... VARIAN
Band 4
Block I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
141.	6G002	8634	PASS			AA
142.	6G005	8634	PASS			AA
143.	6G016	8639	PASS			AA
144.	6G019	8639	PASS			AA
145.	6G026	8639	PASS			AA
146.	6G028	8639	PASS			AA
147.	6G030	8639	PASS			AA
148.	6H009	8643	PASS			AA
149.	6H017	8652	FAIL	3, 12		AA
150.	6H018	8643	PASS			AA
151.	6H019	8639	PASS			AA
152.	6J018	8704	PASS			AA
153.	6K007	8704	PASS			AA
154.	6K009	8652	PASS			AA
155.	6K018	8652	PASS			AA
156.	6K019	8652	PASS			AA
157.	6K020	8652	PASS			AA
158.	6L006	8704	PASS			AA
159.	6L020	8704	PASS			AA
160.	6L026	8704	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 VARIAN Output TWTs

Part Number	583R821H02 *	Vendor	VARIAN
Stock Number	5960-01-040-4442EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
161.	89001	8617	FAIL	9, 12		FF
162.	89009	8626	FAIL	3, 12		FF
163.	8E008	8847	FAIL	10, 12		FF
164.	8F001	8847	PASS	1		AA
165.	8F005	8913	PASS			AA
166.	8F007	8852	PASS			AA
167.	8H014	8847	PASS			AA
168.	8H018	8852	PASS			AA
169.	8J009	8847	PASS			AA
170.	8J012	8904	PASS			AA
171.	8J013	8852	PASS			AA
172.	8J017	8847	FAIL	10, 12		FF
173.	8K001	8852	PASS			AA
174.	8K008	8852	PASS			AA
175.	8K011	8904	PASS			AA
176.	8K012	8904	PASS			AA
177.	8K013	8852	PASS			AA
178.	8K014	8904	PASS			AA
179.	8K015	8852	FAIL	2, 12	FAIL	FF
180.	8L005	8908	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 VARIAN Output TWTs

Part Number .... 583R679H03 *
Stock Number 5960-01-069-8028EW
New TWT .... No

Vendor .... VARIAN
Band 4
Block I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
181.	8L007	8904	PASS			AA
182.	8L008	8904	PASS			AA
183.	8L009	8904	PASS			AA
184.	8L010	8904	PASS		PASS	AA
185.	8L011	8904	PASS			AA
186.	8L013	8904	PASS			AA
187.	8L014	8904	PASS			AA
188.	8L015	8904	PASS			AA
189.	8M001	8904	PASS			AA
190.	8M007	8908	PASS			AA
191.	8M008	8913	FAIL	2, 12	PASS	AA
192.	8M010	8908	PASS			AA
193.	8M013	8913	FAIL	2, 12	PASS	AA
194.	8M014	8913	PASS			AA
195.	9A003	8908	PASS			AA
196.	9A007	8913	FAIL	6, 12		AA
197.	9A008	8913	FAIL	2, 12	PASS	AA
198.	9A011	8913	PASS			AA
199.	9A012	8913	FAIL	6, 3, 12		AA
200.	9B001	8913	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 VARIAN Output TWTs

Part Number	583R821H02 *	Vendor	VARIAN
Stock Number	5960-01-040-4442EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
201.	9B003	8913	PASS			AA
202.	9B004	8913	FAIL	7, 12		FF
203.	9B007	8917	PASS			AA
204.	9B008	8913	FAIL	6, 12		AA
205.	9B009	8913	PASS			AA
206.	9B013	8917	PASS			AA
207.	9B016	8917	PASS			AA
208.	9B017	8917	PASS			AA
209.	9B019	8921	PASS			AA
210.	9B020	8917	PASS			AA
211.	9B027	8921	PASS			AA
212.	9B030	8921	FAIL	5	PASS	AA
213.	9C004	8921	PASS			AA
214.	9C007	8921	PASS			AA
215.	9C008	8921	PASS			AA
216.	9C009	8921	PASS			AA
217.	9C010	8926	FAIL	6, 12	PASS	AA
218.	9C012	8926	PASS			AA
219.	9C014	8921	PASS			AA
220.	9C020	8921	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

3.0 FAILURE REVIEW BOARD (FRB)

3.1 FRB Membership

A Failure Review Board, consisting of a system engineering manager, a transmitter design engineer, a field engineer, and a TWT design engineer met periodically to review TWT test data. The expertise and experience of the members provided a technical basis for determining how interrelated tube parameters could impact system performances and how best to dispose of tubes with questionable test data.

3.2 FRB Pass/Fail Criteria

Tubes that passed the ETM testing were returned to the government as serviceable. Tubes that failed catastrophically were returned as unserviceable, and tubes that failed marginally were reviewed in detail to see if they could be declared serviceable. Gain, power, ripple, helix current, and frequency were considered and compared to the tube specification and system performance requirements. If a failed parameter had sufficient margin, the tube was declared serviceable. If a failed parameter prevented the system from meeting its requirements, the tube was declared unserviceable. In some cases the FRB needed additional data and measurements would be made using either the system or ETM to obtain the data.

Figures 3.2 (a), 3.2 (b), and 3.2 (c) show samples of the different power output measurements observed by the FRB. Figure 3.2 (a) shows a measured output power that exceeds the system and TWT specifications. TWTs that met all of the TWT specifications were returned to the USAF as serviceable. Figure 3.2 (b) shows a measured output power that fails the TWT specification, but passed the system specification. If all other parameters passed, the FRB would return the tubes to the USAF as serviceable.

Figure 3.2 (c) shows a measured output power that fails both the TWT and system specifications. This tube would be returned to the USAF as unserviceable.

Figure 3.2 (d) shows a gain plot where fine-grain (ripple) is measured. If the fine-grain measurement failed the TWT specifications, but passed the system specification, the tube was returned to the USAF as serviceable. If the fine-grain measurement failed both the TWT and system specification, the FRB would return the tube as unserviceable.

FRB PASS/FAIL CRITERIA

RETURNED SERVICEABLE

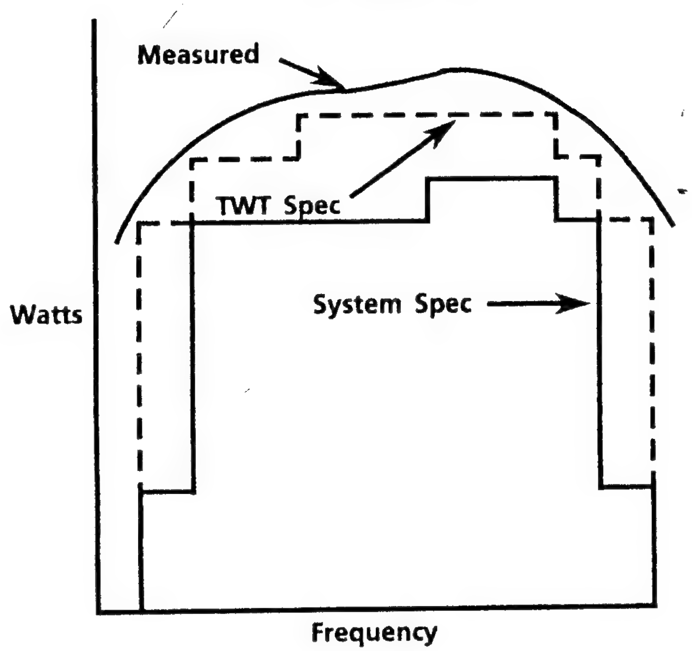


Figure 3.2 (a)

RETURNED SERVICEABLE

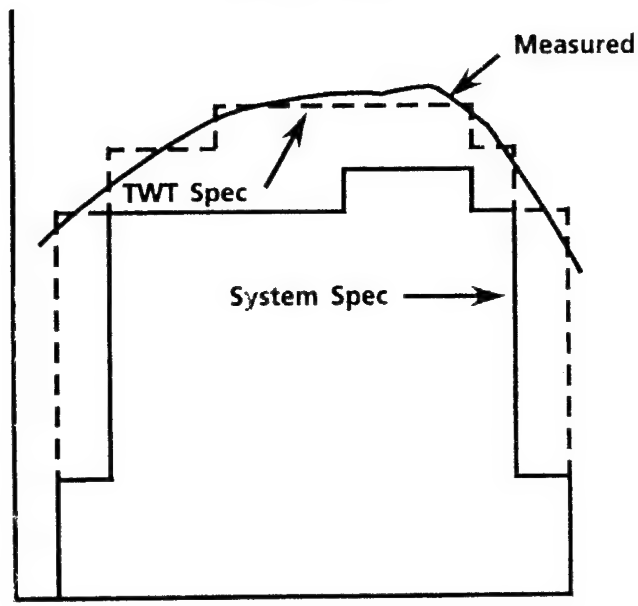


Figure 3.2 (b)

RETURNED UNSERVICEABLE

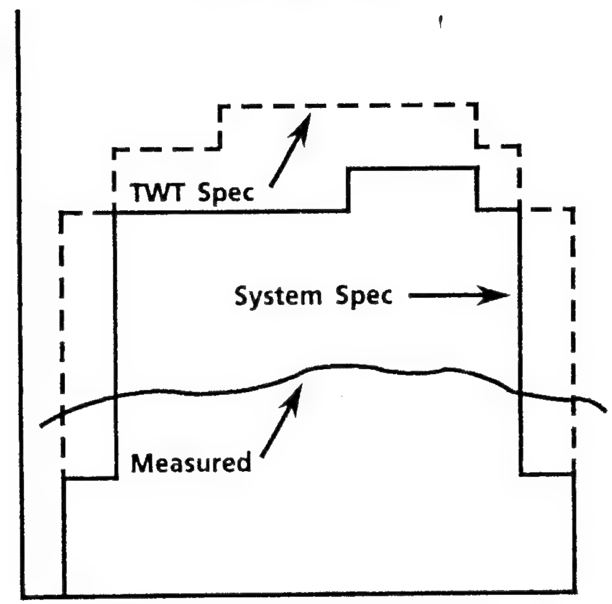


Figure 3.2 (c)

Power Output

AN/ALQ-131 BLOCK I Band 4 VARIAN Output TWTs

Part Number	583R821H02*	Vendor	VARIAN
Stock Number	5960-01-040-4442EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
261.	9H014	8943	PASS			AA
262.	9J001	8947	PASS			AA
263.	9J003	8947	PASS			AA
264.	9J004	8943	PASS			AA
265.	9J005	8947	PASS			AA
266.	9J006	8943	PASS			AA
267.	9J007	8947	PASS			AA
268.	9J009	8947	PASS			AA
269.	9J012	8952	PASS			AA
270.	9J014	8947	FAIL	6, 12	PASS	AA
271.	9J016	8947	PASS			AA
272.	9J020	8952	PASS			AA
273.	9J022	8952	PASS			AA
274.	9K004	8952	FAIL	9	FAIL	FF

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 VARIAN Output TWTs

Part Number	583R822H02*	Vendor	VARIAN
Stock Number	5960-01-040-4441EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
1.	10027	8913	FAIL	9	FAIL	FF
2.	10081	8930	PASS			AA
3.	10082	8930	PASS			AA
4.	10084	8930	PASS			AA
5.	10085	8930	FAIL	2		AA
6.	10088	8930	PASS			AA
7.	10089	8930	PASS			AA
8.	10090	8930	FAIL	9, 10	PASS	FF
9.	10093	8934	PASS			AA
10.	10095	8934	PASS			AA
11.	10098	8934	FAIL	2		AA
12.	10101	8934	PASS			AA
13.	10105	8934	PASS			AA
14.	10123	8939	PASS			AA
15.	10124	8939	PASS			AA
16.	10126	8939	PASS			AA
17.	10127	8939	PASS			AA
18.	10130	8939	FAIL	4, 2		AA
19.	10131	8939	PASS			AA
20.	10134	8943	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 VARIAN Output TWTs

Part Number	583R822H02*	Vendor ...	VARIAN
Stock Number	5960-01-040-4441EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
21.	10135	8943	PASS			AA
22.	10137	8943	PASS			AA
23.	10139	8943	FAIL	4		AA
24.	10140	8943	PASS			AA
25.	10141	8943	FAIL	4		AA
26.	10142	8943	PASS			AA
27.	10144	8943	PASS			AA
28.	10146	8943	PASS			AA
29.	10147	8943	PASS			AA
30.	10150	8943	PASS			AA
31.	10151	8943	PASS			AA
32.	10152	8943	FAIL	4		AA
33.	10156	8943	PASS			AA
34.	10157	8943	PASS			AA
35.	10159	8947	FAIL	5		FF
36.	10161	8947	PASS			AA
37.	10162	8947	PASS			AA
38.	10163	8947	PASS			AA
39.	10164	8947	PASS			AA
40.	10165	8947	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 VARIAN Output TWTs

Part Number	583R822H02*	Vendor	VARIAN
Stock Number	5960-01-040-4441EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
41.	10168	8952	PASS			AA
42.	10169	8952	PASS			AA
43.	10170	8952	PASS			AA
44.	10171	8952	PASS			AA
45.	10172	8952	PASS			AA
46.	10173	8952	PASS			AA
47.	10174	8952	PASS			AA
48.	10175	8952	PASS			AA
49.	10177	8952	FAIL	4		AA
50.	10184	8952	FAIL	4		AA
51.	10186	8952	FAIL	5	FAIL	FF
52.	10190	9004	PASS			AA
53.	10191	9004	FAIL	4, 12		AA
54.	10192	9004	PASS			AA
55.	10193	9004	PASS			AA
56.	10194	9004	PASS			AA
57.	10197	9004	PASS			AA
58.	10198	9004	PASS			AA
59.	10199	9004	PASS			AA
60.	10200	9004	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 VARIAN Output TWTs

Part Number	583R822H02*	Vendor	VARIAN
Stock Number	5960-01-040-4441EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
61.	10201	9004	PASS			AA
62.	10203	9004	PASS			AA
63.	10204	9004	PASS			AA
64.	10205	9004	PASS			AA
65.	10206	9004	PASS			AA
66.	10207	9004	FAIL	5		FF
67.	10208	9004	PASS			AA
68.	10209	9004	PASS			AA
69.	10210	9004	PASS		PASS	AA
70.	10211	9004	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK II Band 4 TMEC Output TWTs

Part Number	585R182H02*	Vendor	TMEC
Stock Number	5960-01-116-8859EW	Band	4
New TWT	Yes	Block	II

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
1.	4361079	9013	PASS			AA
2.	4361083	9014	FAIL	9		AA
3.	4361086	9015	PASS			AA
4.	4361088	9019	PASS			AA
5.	4361089,	9019	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

Output TWT Summary Report

I. New Band 3 TMEC Output TWTs

ETM Screening:

Quantity screened	39
Quantity passed	34
Quantity failed	5
ETM failure rate	12.8%

Review Board Results:

Quantity reviewed	5
Quantity passed	1
Quantity failed	4

System Test:

Quantity system tested	8
Quantity passed	7
Quantity failed	1
System failure rate	12.5%

Overall Program Results:

Quantity received	39
Quantity condition code A	35
Condition code A rate	89.7%

II. Used Band 3 Litton Output TWTs

ETM Screening:

Quantity screened	26
Quantity passed	1
Quantity failed	25
ETM failure rate	96.2%

Review Board Results:

Quantity reviewed	25
Quantity passed	3
Quantity failed	22

System Test:

Quantity system tested	22
Quantity passed	11
Quantity failed	11
System failure rate	50.0%

Overall Program Results:

Quantity received	26
Quantity condition code A	4
Condition code A rate	15.4%

III. Used Band 3 Varian Output TWTs

ETM Screening:

Quantity screened	118
Quantity passed	36
Quantity failed	82
ETM failure rate	69.5%

Review Board Results:

Quantity reviewed	82
Quantity passed	25
Quantity failed	57

System Test:

Quantity system tested	14
Quantity passed	9
Quantity failed	5
System failure rate	35.7%

Overall Program Results:

Quantity received	118
Quantity condition code A	61
Condition code A rate	51.7%

Output TWT Summary Report

IV. New Band 4 Varian Output TWTs

ETM Screening:		System Test:	
Quantity screened	274	Quantity system tested	28
Quantity passed	222	Quantity passed	20
Quantity failed	52	Quantity failed	8
ETM failure rate	19.0%	System failure rate	28.6%
Review Board Results:		Overall Program Results:	
Quantity reviewed	52	Quantity received	274
Quantity passed	17	Quantity condition code A	239
Quantity failed	35	Condition code A rate	87.2%

V. New Band 4 TMEC Output TWTs

ETM Screening:		System Test:	
Quantity screened	5	Quantity system tested	0
Quantity passed	4	Quantity passed	0
Quantity failed	1	Quantity failed	0
ETM failure rate	20.0%	System failure rate	0.0%
Review Board Results:		Overall Program Results:	
Quantity reviewed	1	Quantity received	5
Quantity passed	1	Quantity condition code A	5
Quantity failed	0	Condition code A rate	100%

VI. New Band 5 Varian Output TWTs

ETM Screening:		System Test:	
Quantity screened	70	Quantity system tested	4
Quantity passed	56	Quantity passed	2
Quantity failed	14	Quantity failed	2
ETM failure rate	20.0%	System failure rate	50.0%
Review Board Results:		Overall Program Results:	
Quantity reviewed	14	Quantity received	70
Quantity passed	9	Quantity condition code A	65
Quantity failed	5	Condition code A rate	92.9%

AN/ALQ-131 Output TWTs

Output TWT Failure Codes

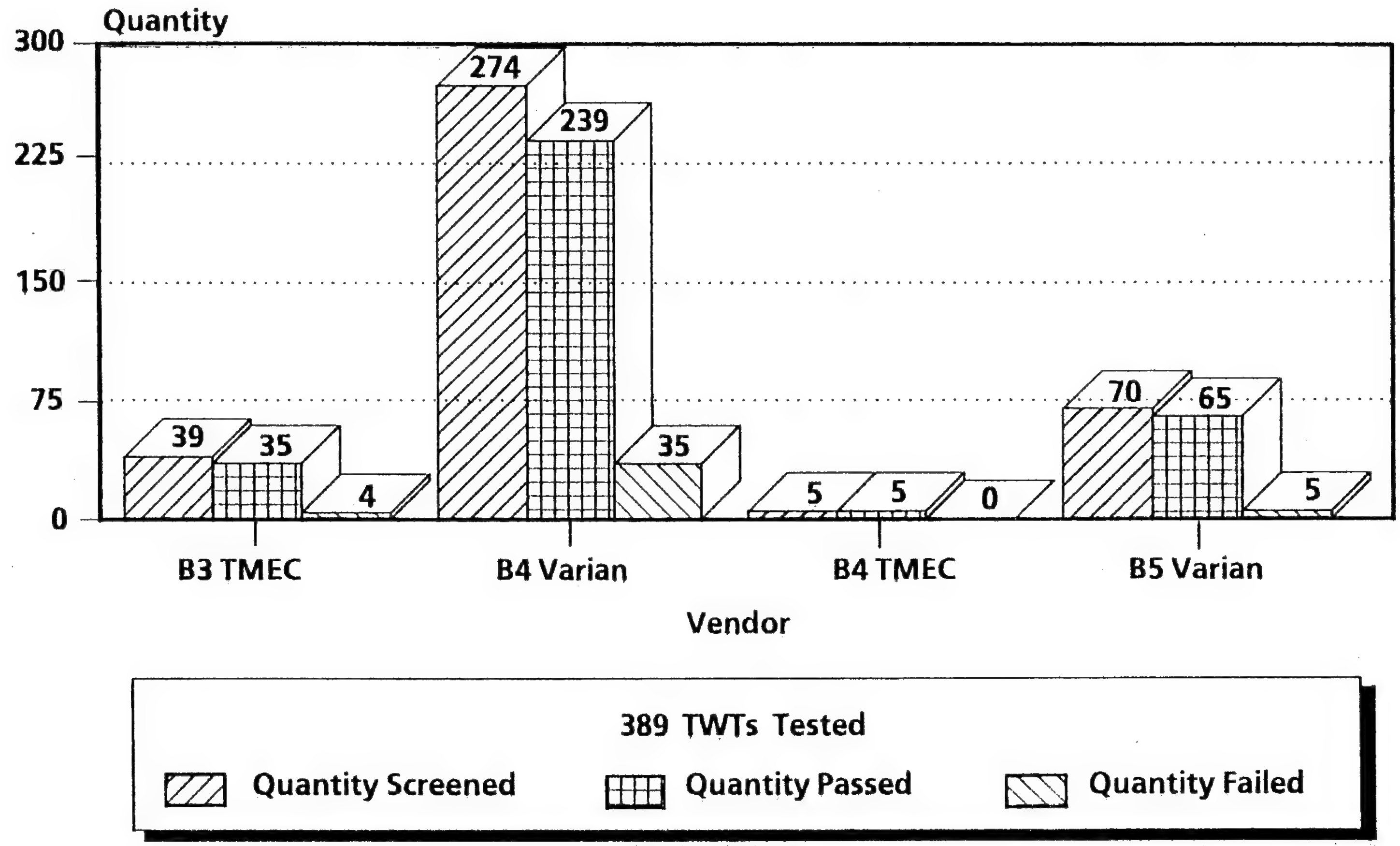
1. *Minor problems (Passed after extended burn-in, etc.)*
2. *Gain*
3. *Fine grain (ripple)*
4. *Power*
5. *HYPOT*
6. *Helix*
7. *Gassy*
8. *Grid leakage*
9. *BWO*
10. *Mechanical*
11. *Perveance (unstable gun)*
12. *Re-optimization Candidate*

TWT Status Codes

1. *AA - Serviceable TWT*
2. *FF - Unserviceable TWT*
3. *ZM - Recommend return to manufacturer*
4. *FRB - Requires retesting for additional information*
5. *ZS - Requires system testing*
6. *ZH - Hold pending other test results*
7. *ZZ - Awaiting review by FRB*
8. *PP - Awaiting disposition*
9. *RT - Requires retesting*

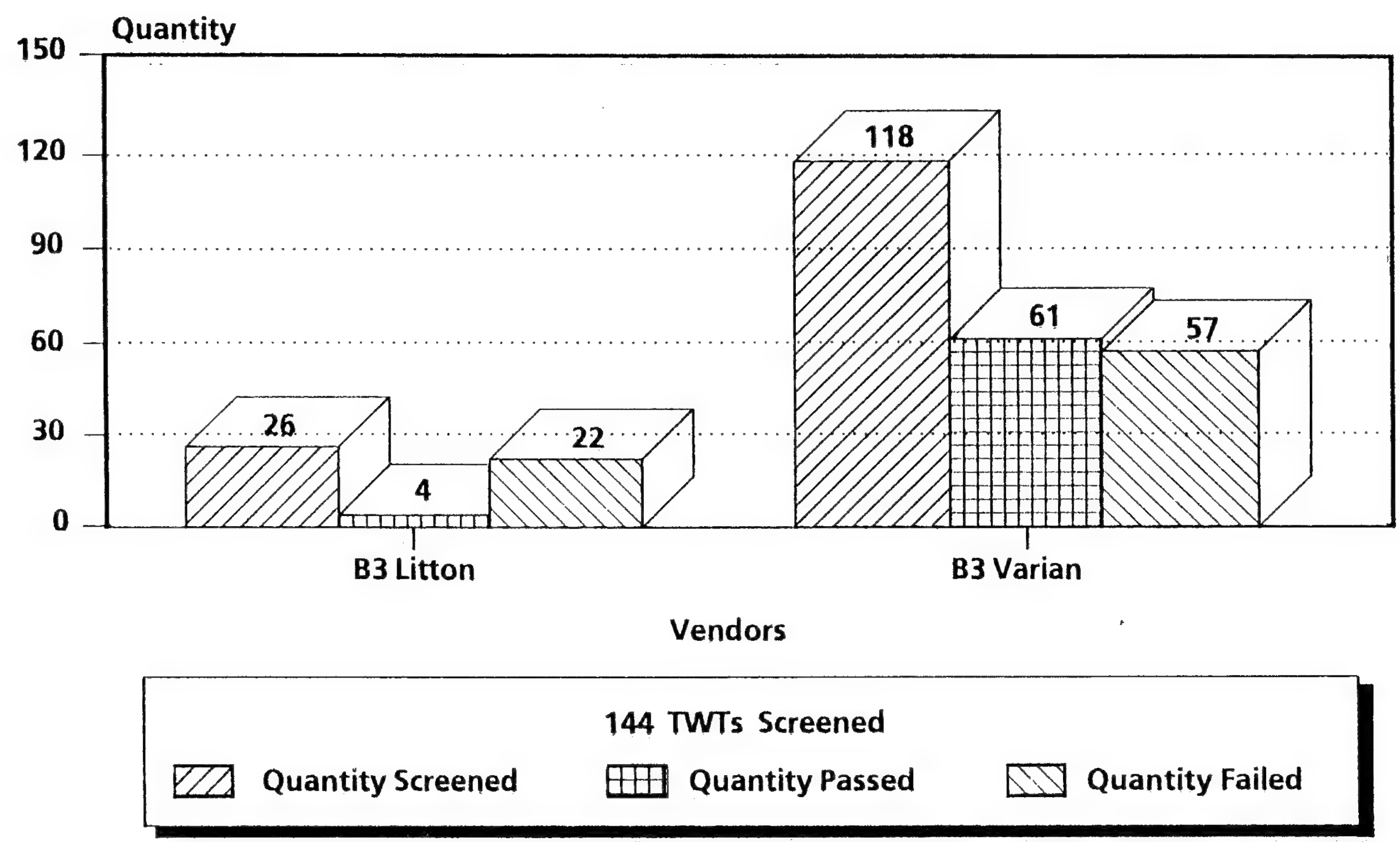
AN/ALQ-131 OUTPUT TWTs

Program Summary: New Band 3, 4, and 5 TWTs



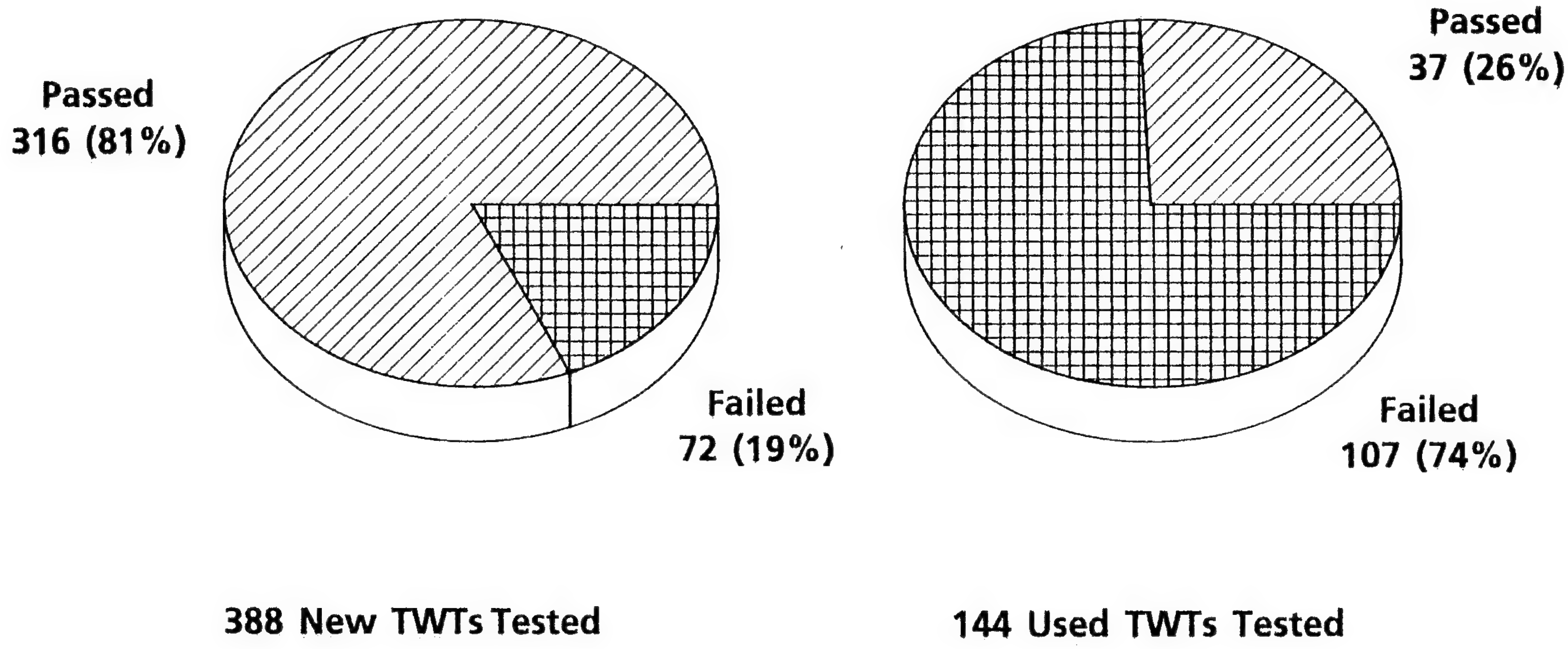
AN/ALQ-131 OUTPUT TWTs

Program Summary: Used Band 3 TWTs



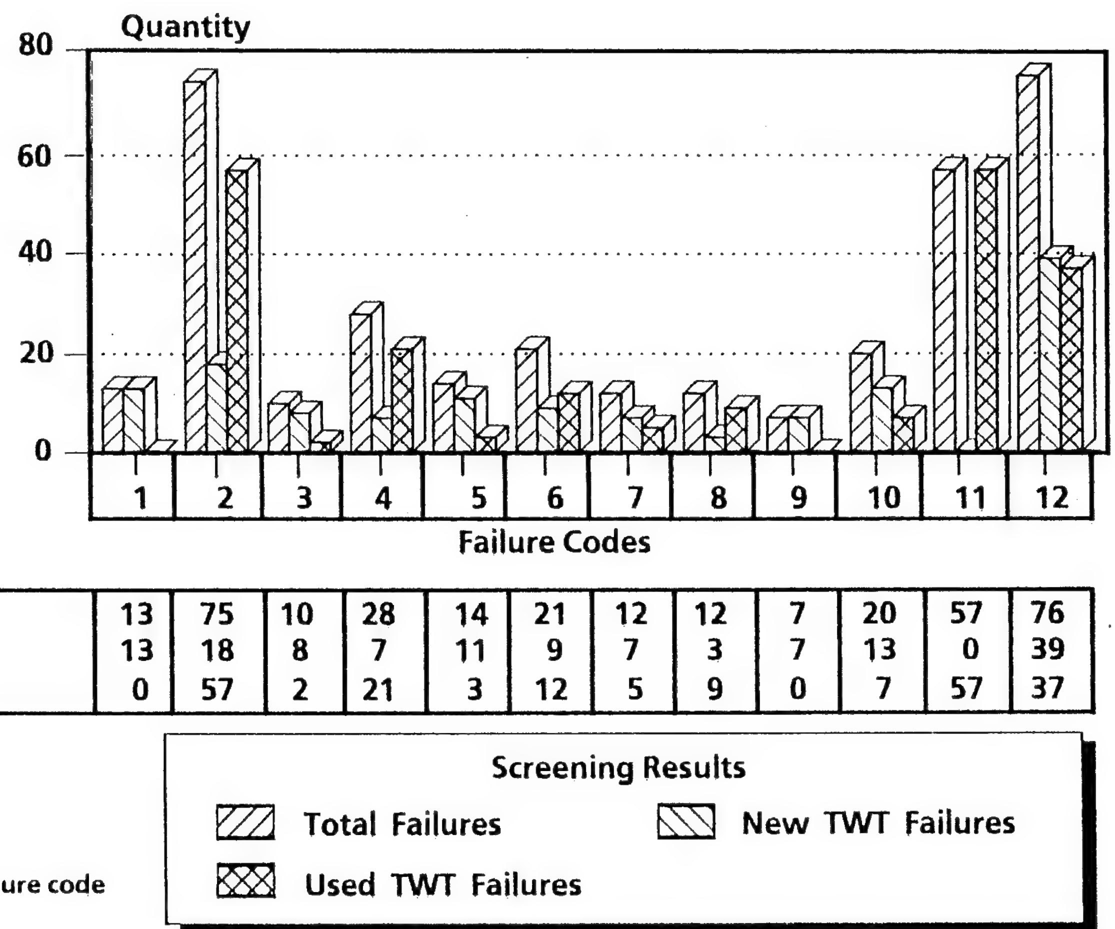
AN/ALQ-131 OUTPUT TWTs

Screening Summary: New vs. Used



AN/ALQ-131 OUTPUT TWTs

Screening Summary: New vs. Used by Failure Codes



	1	2	3	4	5	6	7	8	9	10	11	12
Total Failures	13	75	10	28	14	21	12	12	7	20	57	76
New TWT Failures	13	18	8	7	11	9	7	3	7	13	0	39
Used TWT Failures	0	57	2	21	3	12	5	9	0	7	57	37

* Each TWT may have more than one failure code

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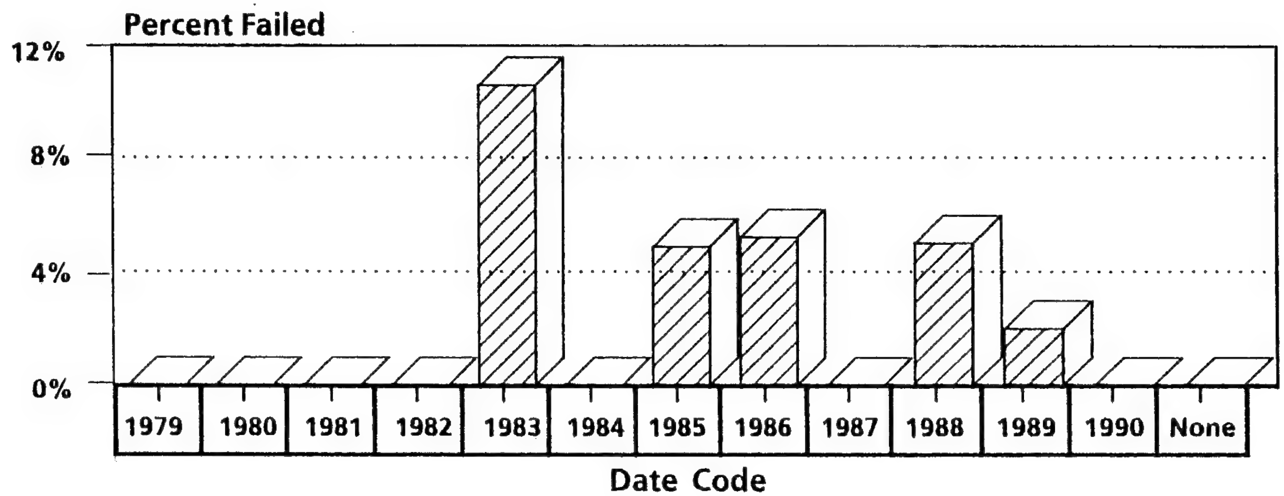
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 1)



Percent Failed/Year	0%	0%	0%	0%	10.5%	0%	4.9%	5.2%	0%	5.0%	2.0%	0%	0%

532 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

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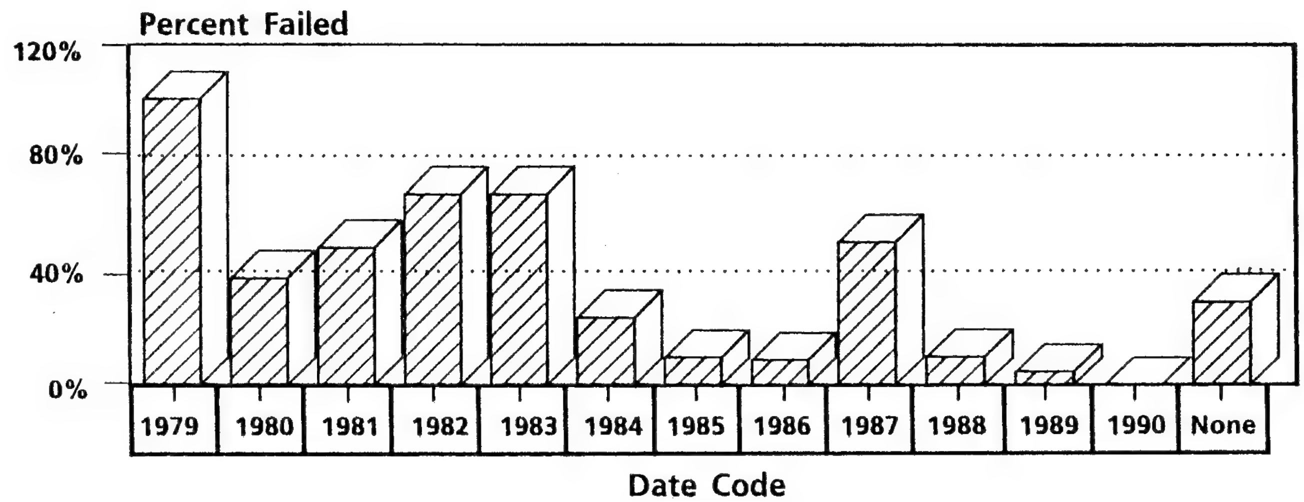
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 2)



Percent Failed/Year	100%	37.5%	48.4%	66.7%	66.7%	23.9%	9.8%	8.9%	5.0%	1.0%	4.6%	0%	29.2%

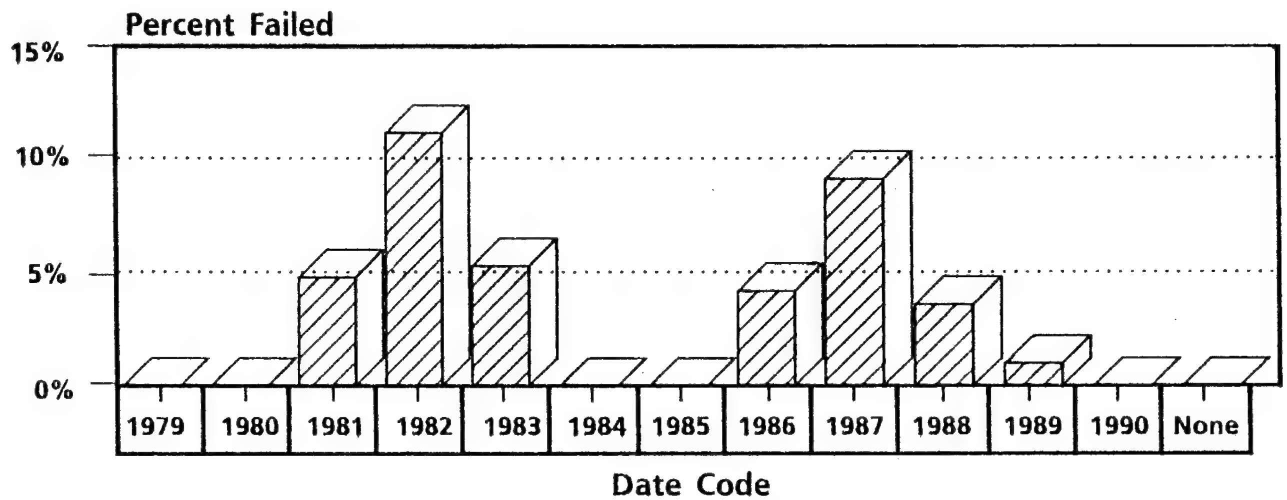
532 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 3)



Percent Failed/Year	0%	0%	4.8%	11.1%	5.3%	0%	0%	4.2%	9.1%	3.6%	1.0%	0%	0%

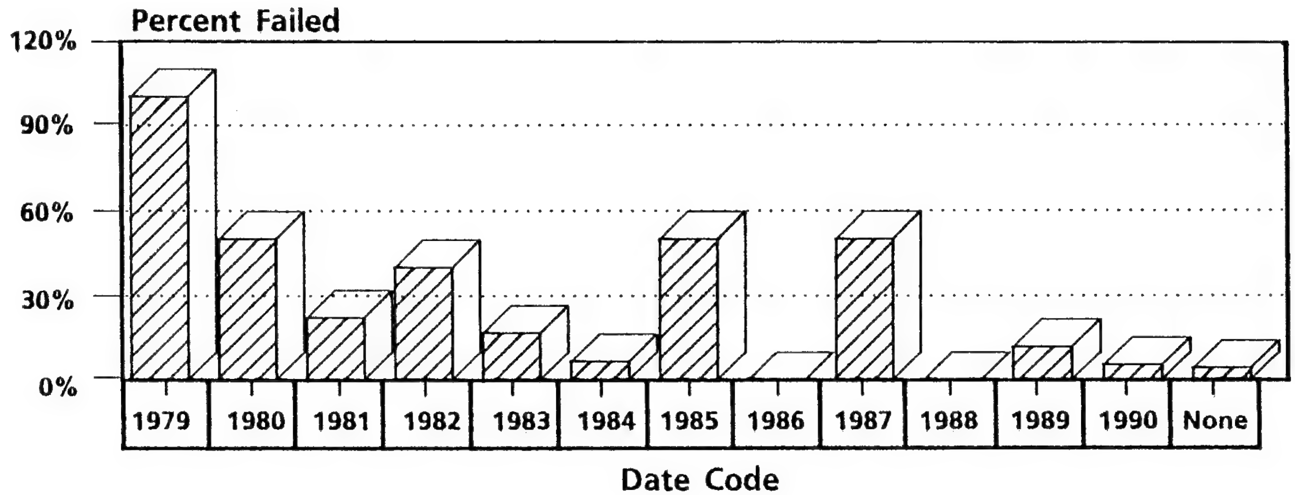
532 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 4)



Percent Failed/Year	100%	50%	22.2%	40%	16.7%	6.5%	50%	0%	5.0%	0%	11.8%	5.3%	4.2%

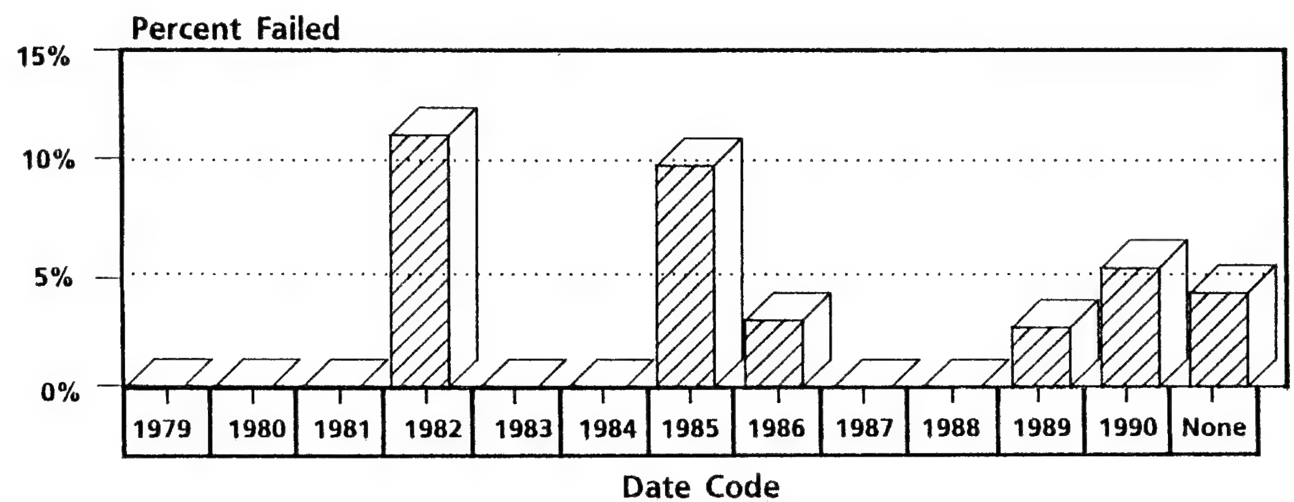
532 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 5)



	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	None
Percent Failed/Year	0%	0%	0%	11.1%	0%	0%	9.8%	3.0%	0%	0%	2.6%	5.3%	4.2%

532 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

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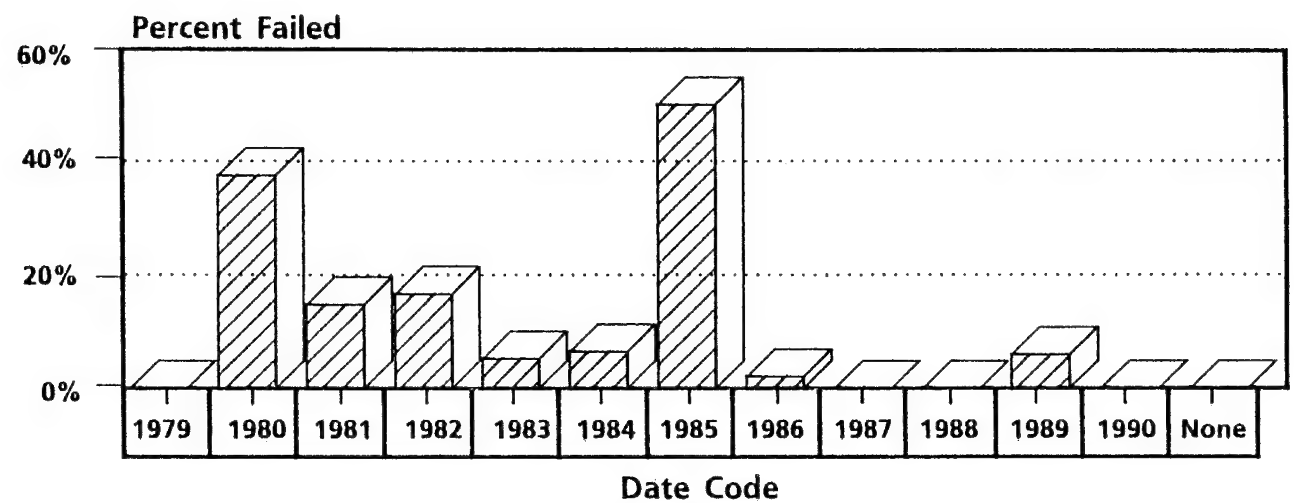
Warner Robins, Georgia

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 6)



Percent Failed/Year	0%	37.5%	14.8%	16.7%	5.3%	6.5%	50%	2.1%	0%	0%	6.0%	0%	0%

532 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

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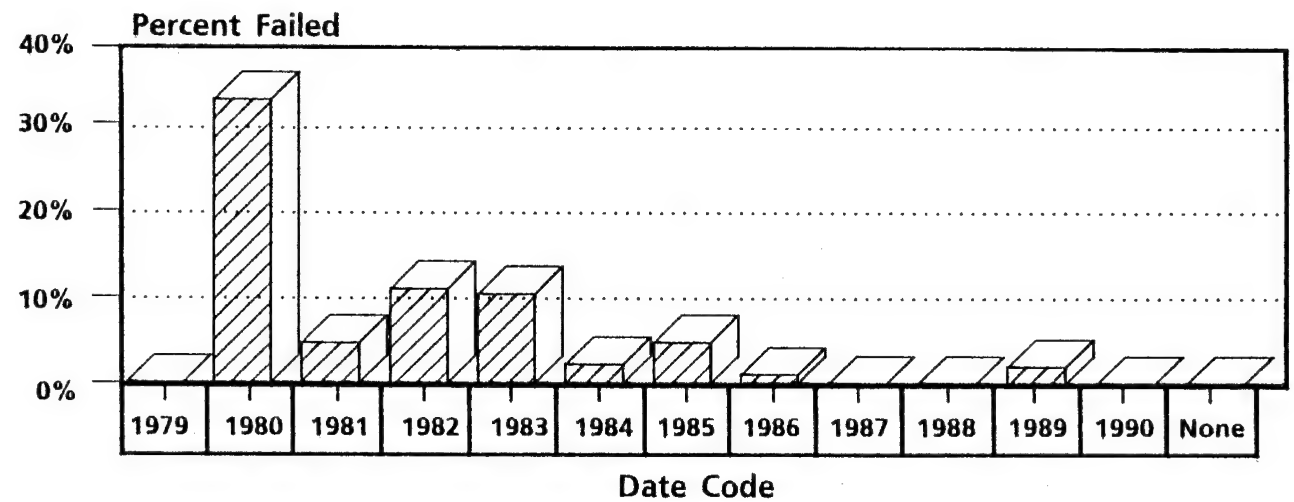
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 7)



	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	None
Percent Failed/Year	0%	33.3%	4.8%	11.1%	10.5%	2.3%	4.9%	1.0%	0%	0%	2.0%	0%	0%

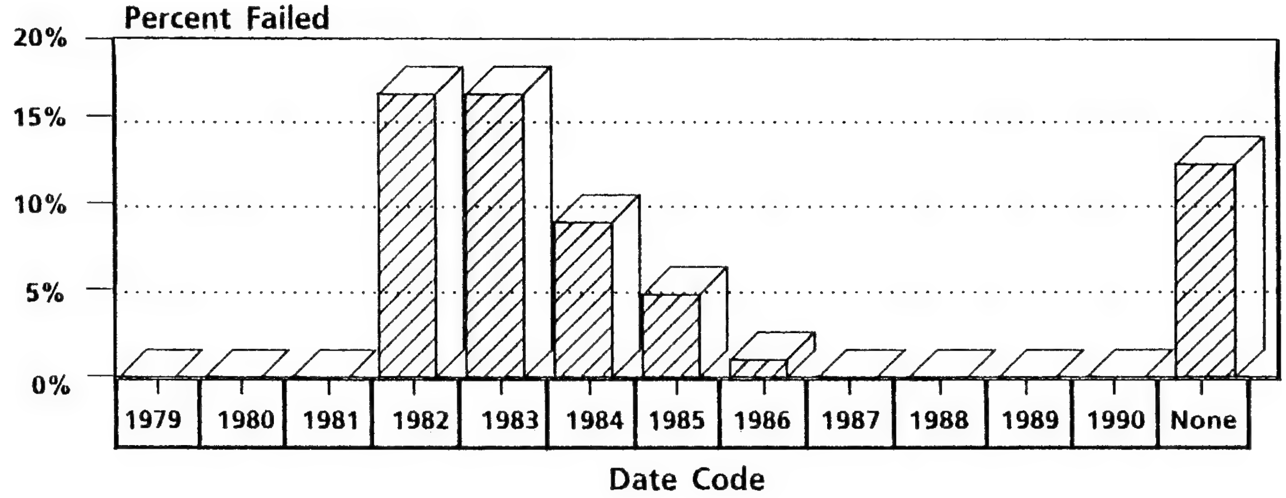
532 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 8)



Percent Failed/Year	0%	0%	0%	16.7%	16.7%	9.1%	4.9%	1.0%	0%	0%	0%	0%	12.5%

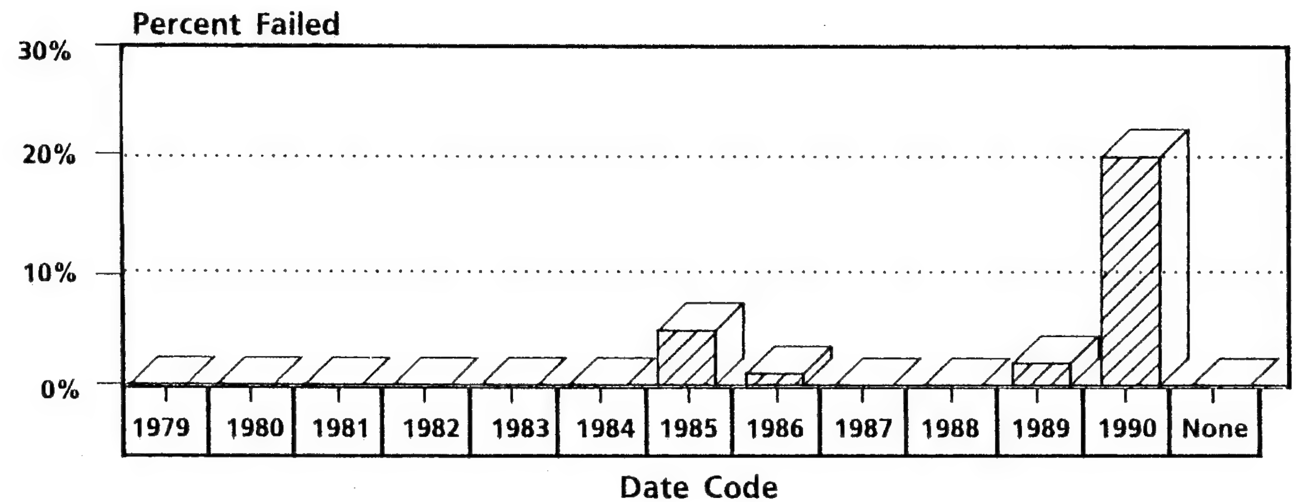
532 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 9)



Percent Failed/Year	0%	0%	0%	0%	0%	0%	4.9%	1.0%	0%	0%	2.0%	20%	0%

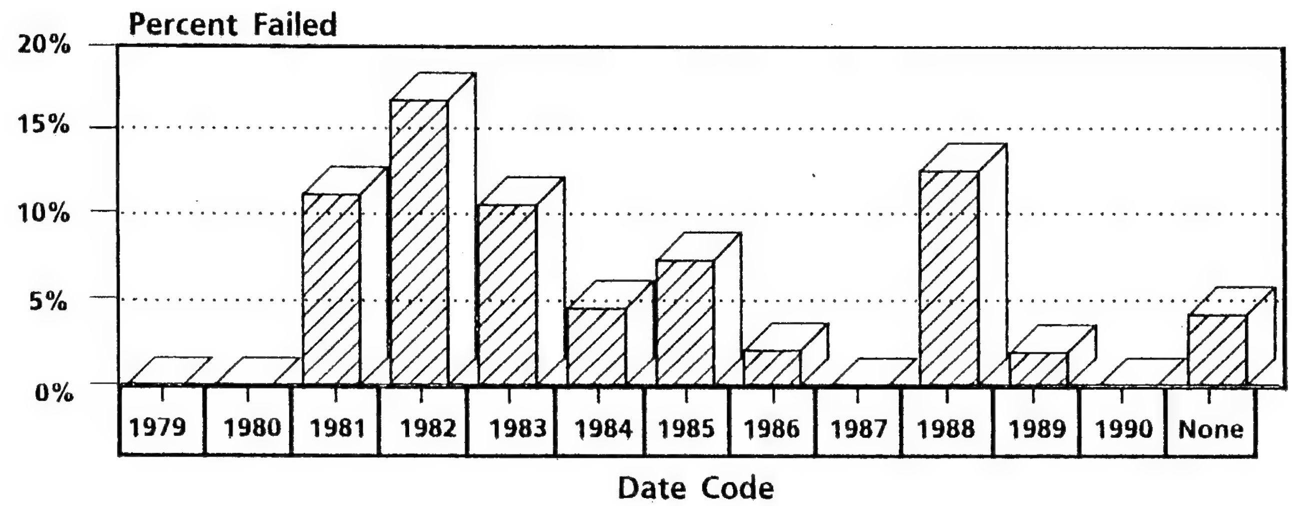
532 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 10)



Percent Failed/Year	0%	0%	11.1%	16.7%	10.5%	4.5%	7.3%	2.1%	0%	12.5%	2.0%	0%	4.2%

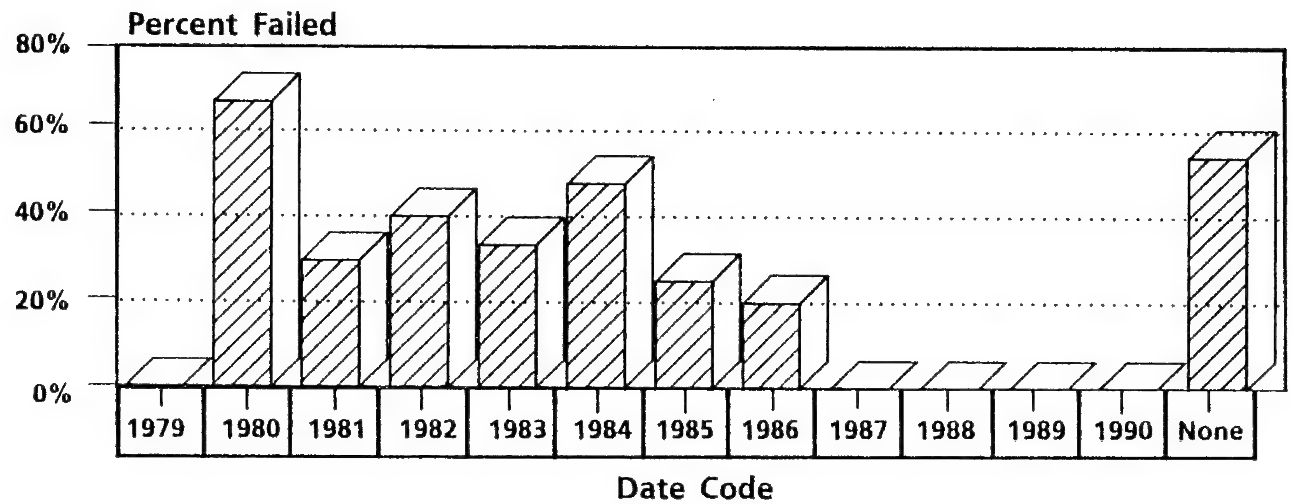
532 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 11)



Percent Failed/Year	0%	66.7%	29.6%	40.0%	33.3%	47.7%	25.0%	20.0%	0%	0%	0%	0%	54.2%

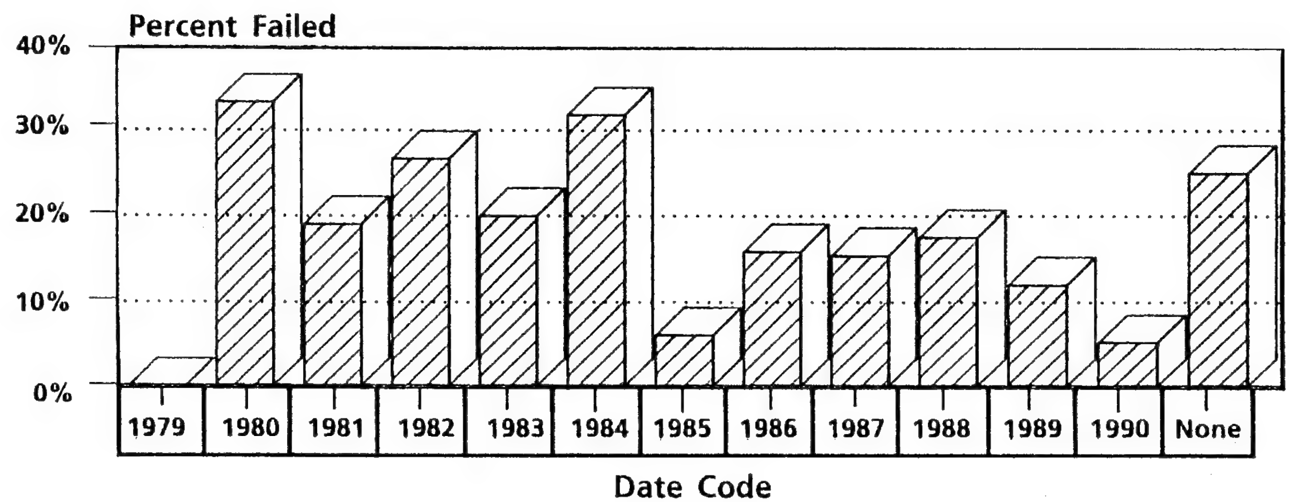
532 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 12)



Percent Failed/Year	0%	33.3%	19.0%	26.7%	20.0%	31.8%	6.1%	15.8%	15.4%	17.5%	12.0%	5.3%	25.0%

532 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
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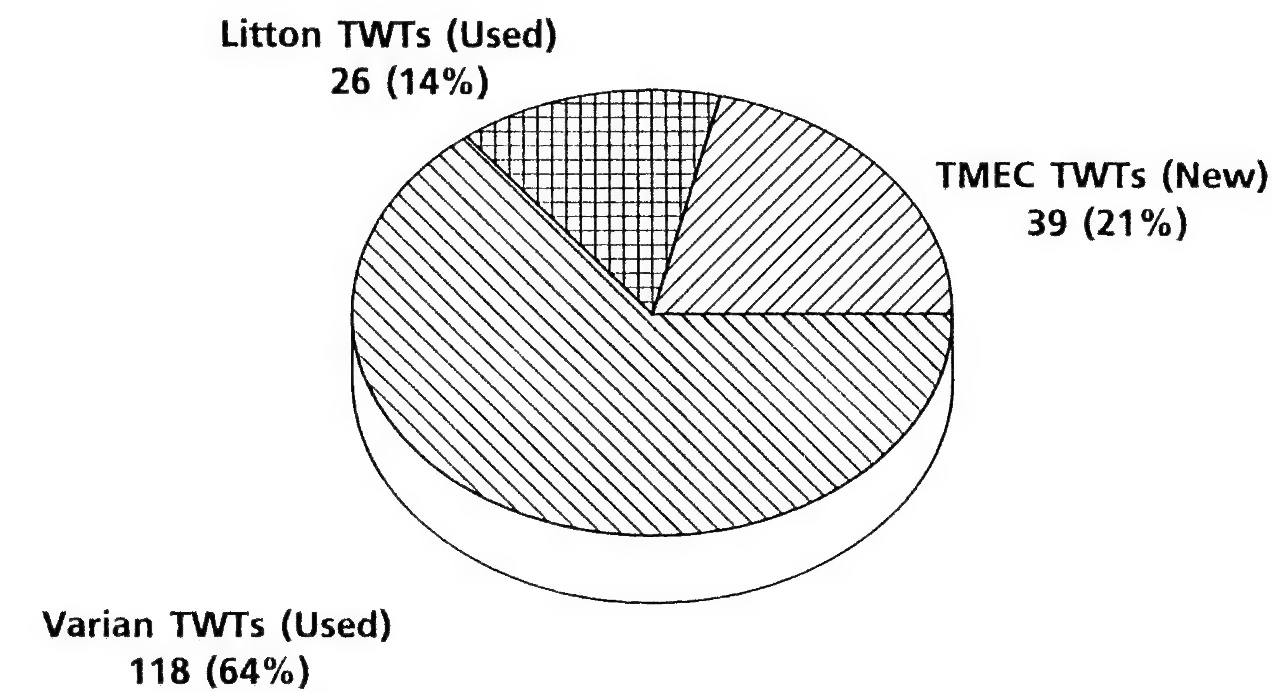
AN/ALQ-131 OUTPUT TWTs

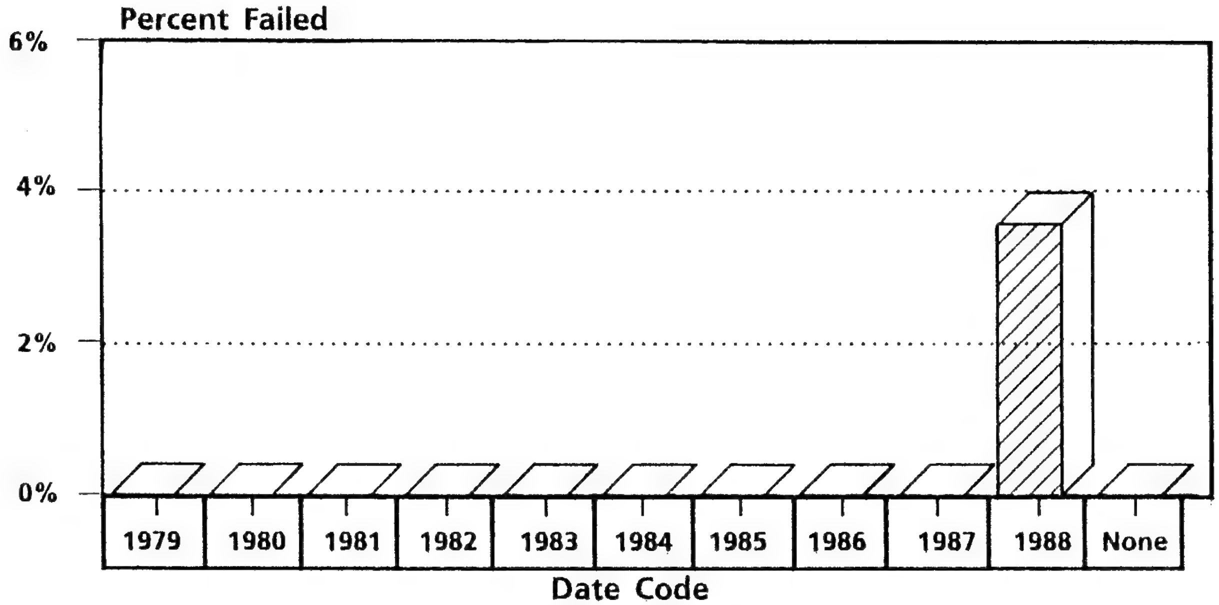
Screening Summary: Band 3 TWTs by Vendor



183 TWTs Tested

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (New & Used)
(Failure Code 1)



	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	None
Percent Failed/Year	0%	0%	0%	0%	0%	0%	0%	0%	0%	3.6%	0%

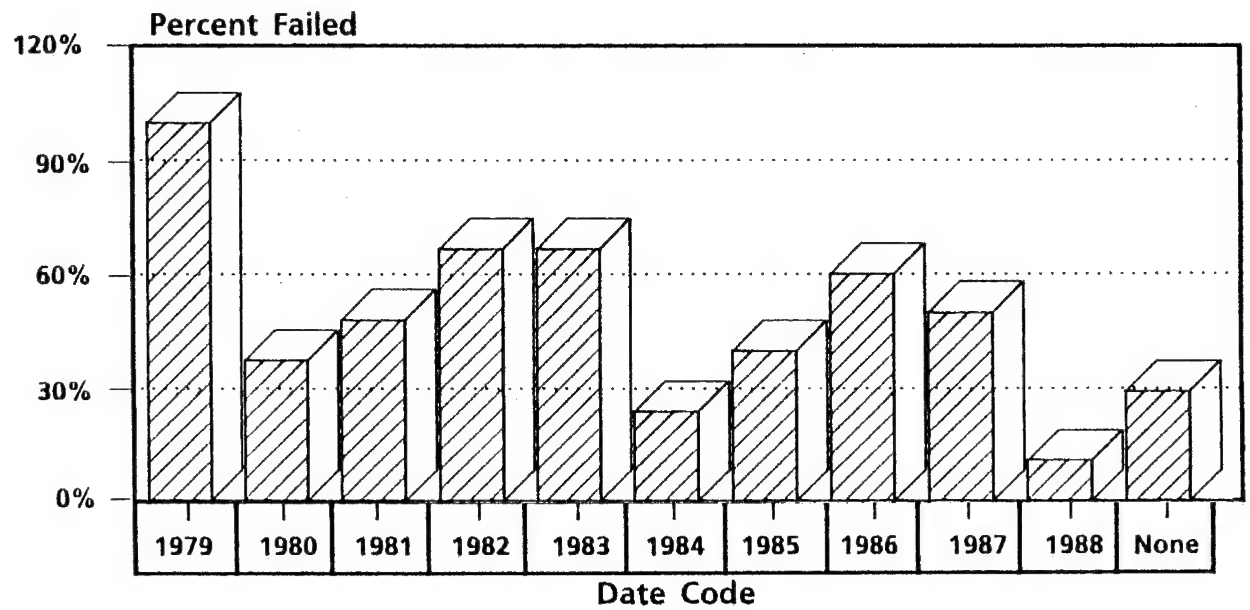
183 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (New & Used)
(Failure Code 2)



	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	None
Percent Failed/Year	100%	37.5%	48.1%	66.7%	66.7%	23.9%	40.0%	60.0%	50.0%	10.7%	29.2%

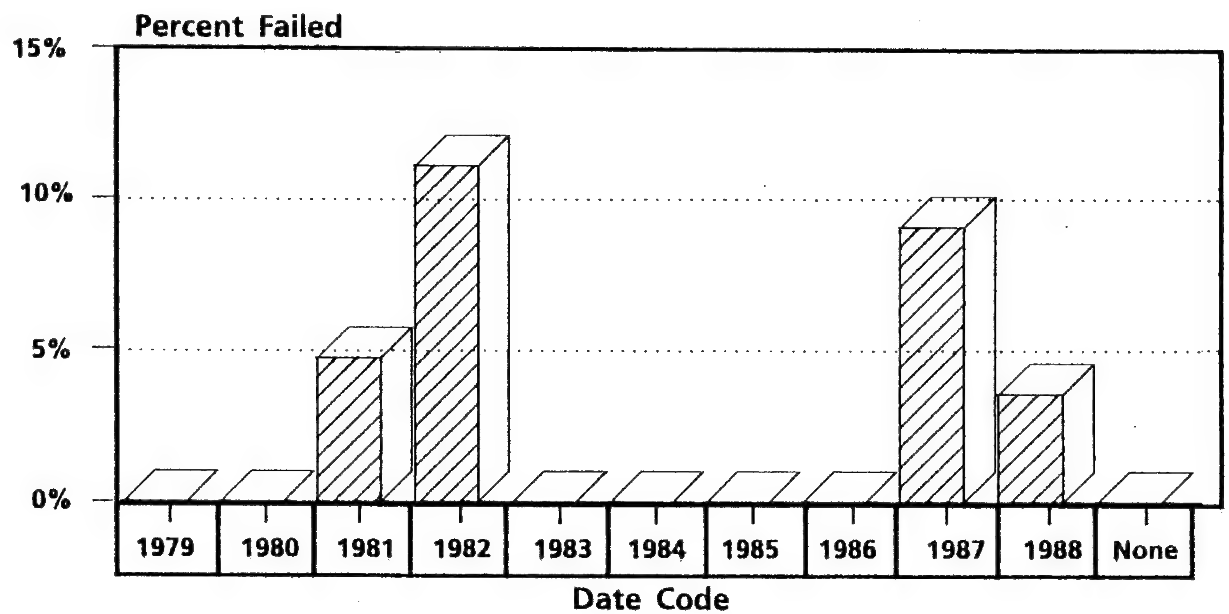
183 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (New & Used)
(Failure Code 3)



	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	None
Percent Failed/Year	0%	0%	4.8%	11.1%	0%	0%	0%	0%	9.1%	3.6%	0%

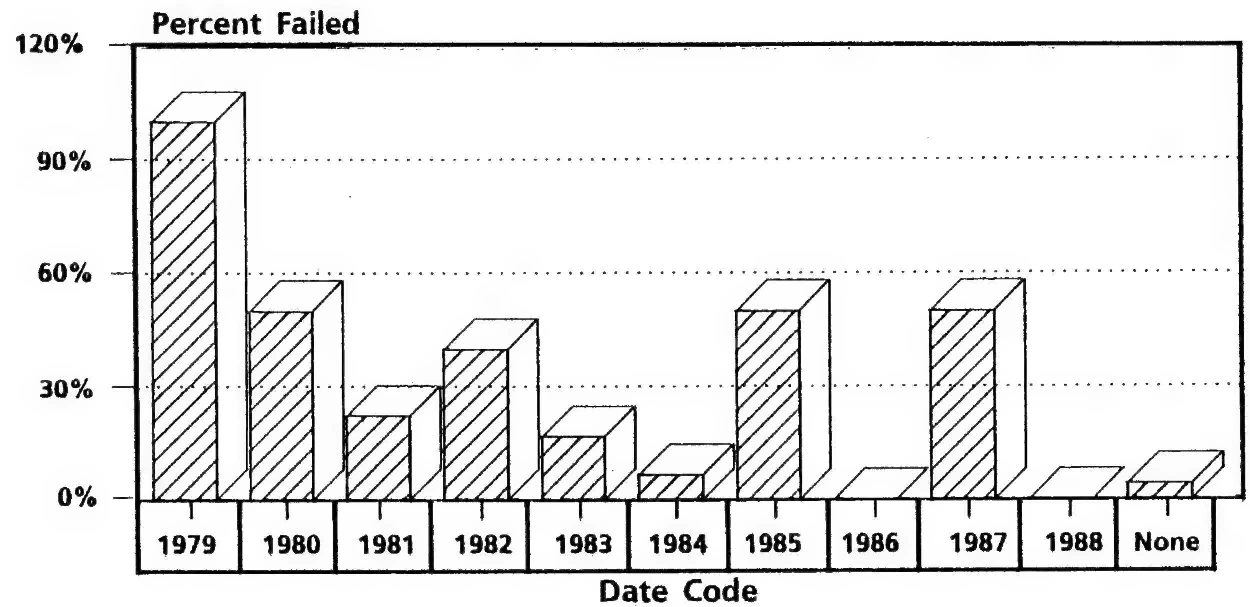
183 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (New & Used)
(Failure Code 4)

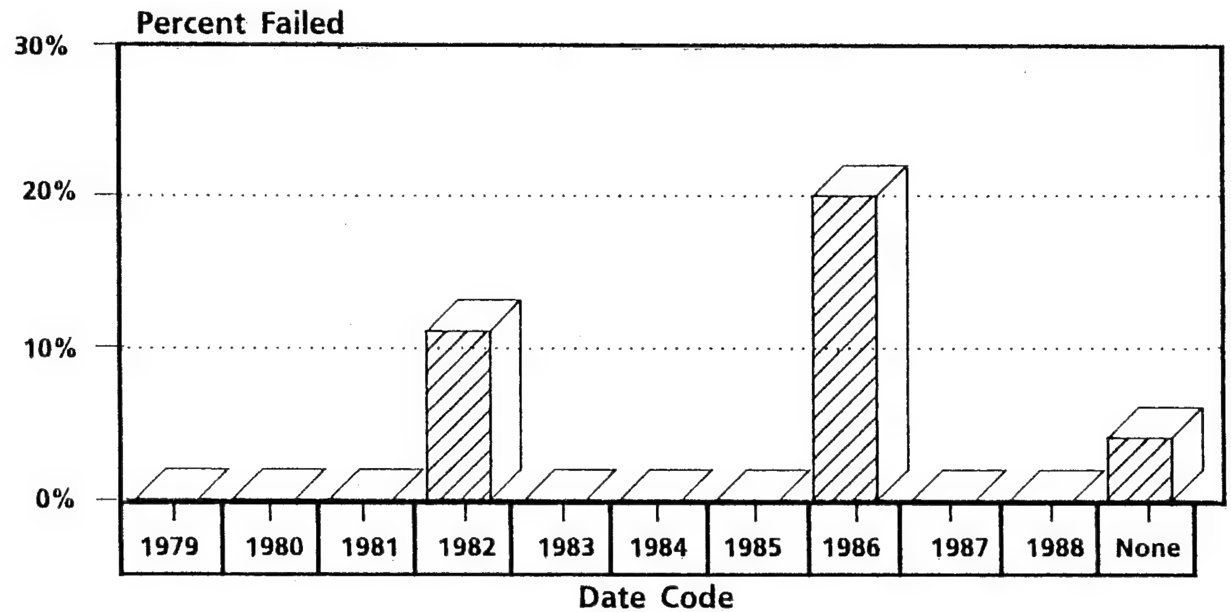


	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	None
Percent Failed/Year	100%	50%	22.2%	40%	16.7%	6.5%	50%	0%	50%	0%	4.2%

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (New & Used)
(Failure Code 5)



Percent Failed/Year	0%	0%	0%	11.1%	0%	0%	0%	20%	0%	0%	4.2%

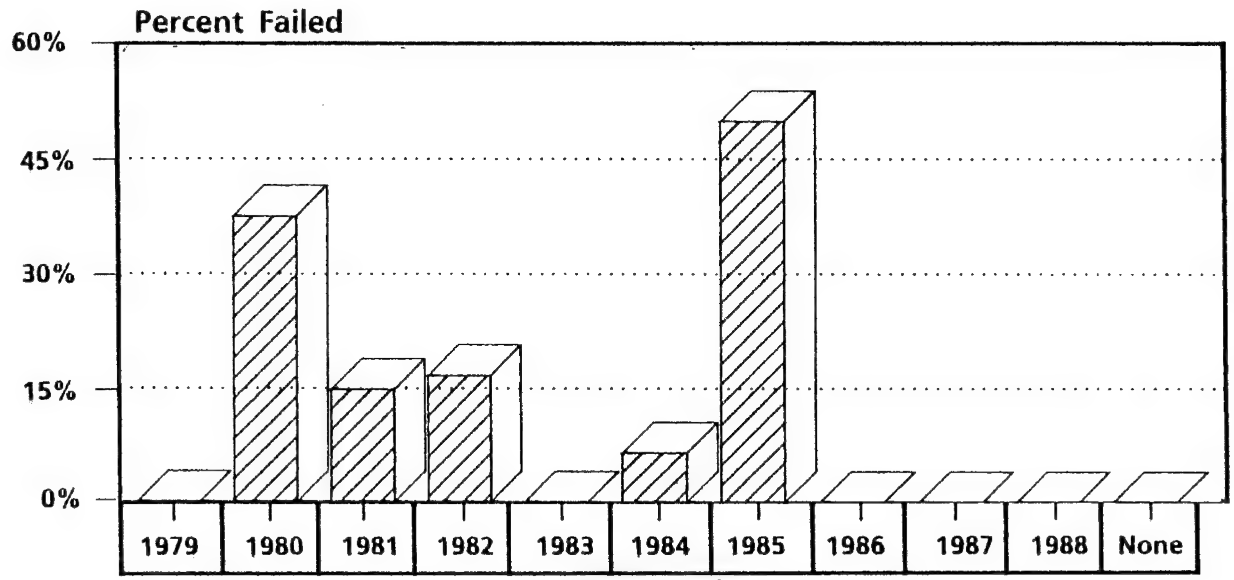
183 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (New & Used)
(Failure Code 6)



Percent Failed/Year	0%	37.5%	14.8%	16.7%	0%	6.5%	50%	0%	0%	0%	0%

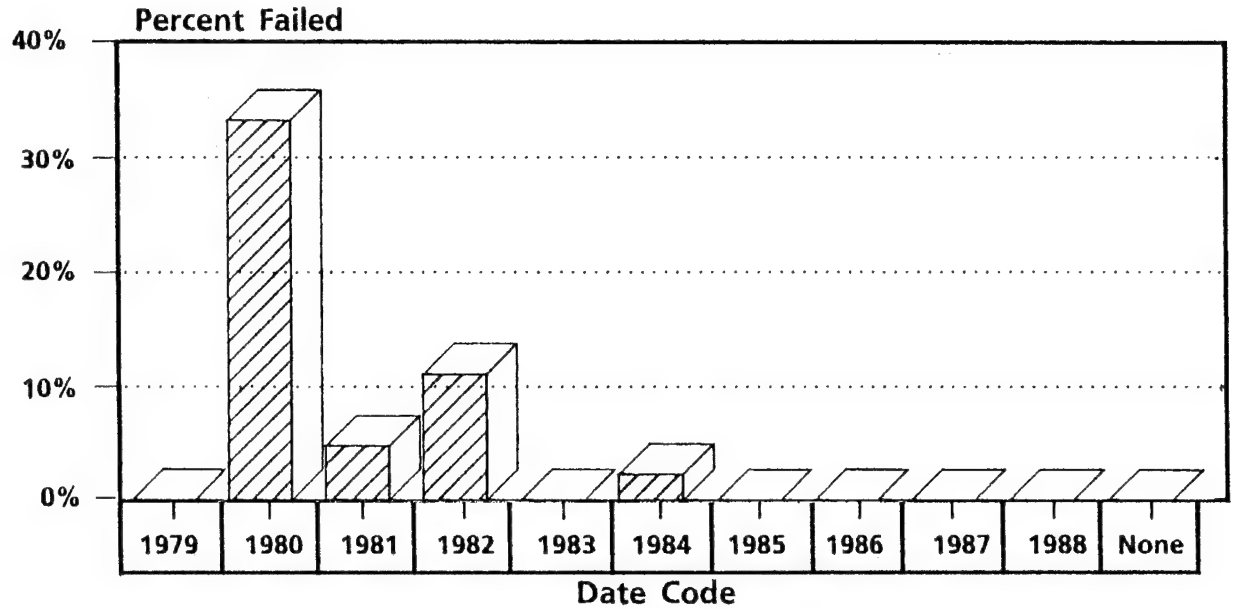
183 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (New & Used)
(Failure Code 7)



	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	None
Percent Failed/Year	0%	33.3%	4.8%	11.1%	0%	2.3%	0%	0%	0%	0%	0%

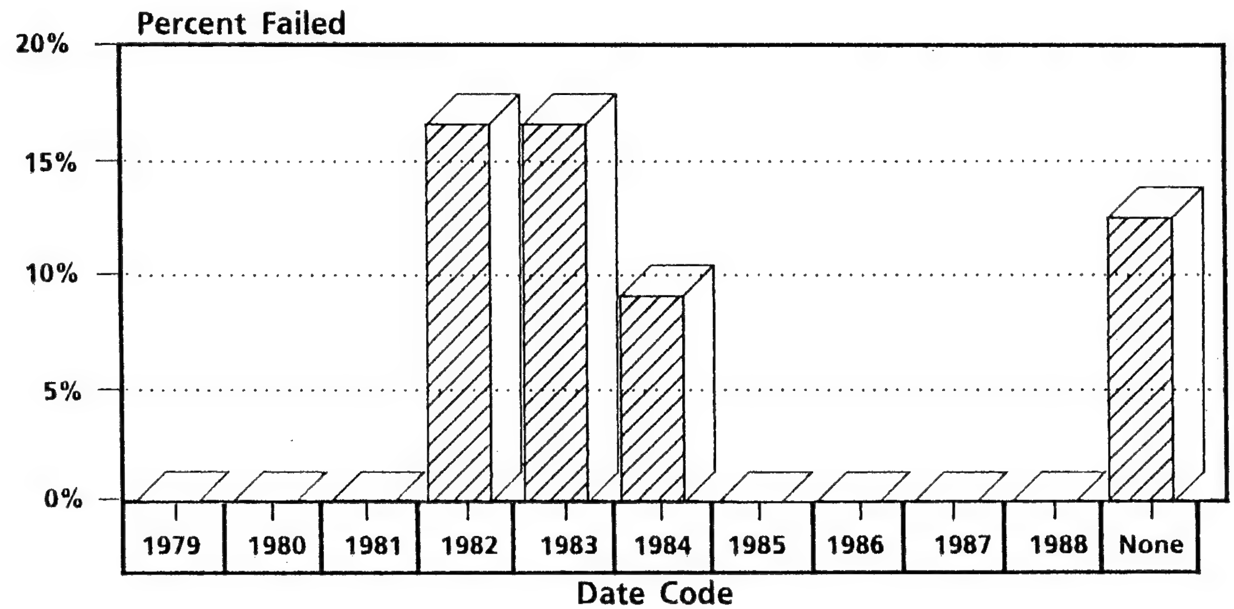
183 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (New & Used)
(Failure Code 8)

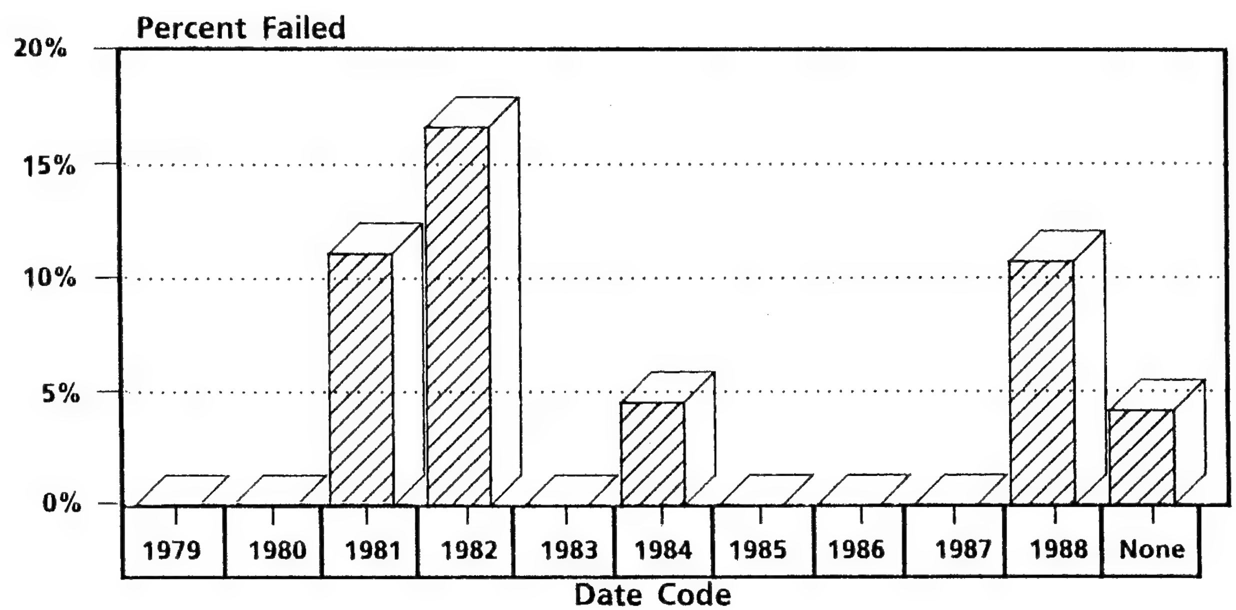


	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	None
Percent Failed/Year	0%	0%	0%	16.7%	16.7%	9.1%	0%	0%	0%	0%	12.5%

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (New & Used)
(Failure Code 10)



Percent Failed/Year	0%	0%	11.1%	16.7%	0%	4.5%	0%	0%	0%	10.7%	4.2%

183 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

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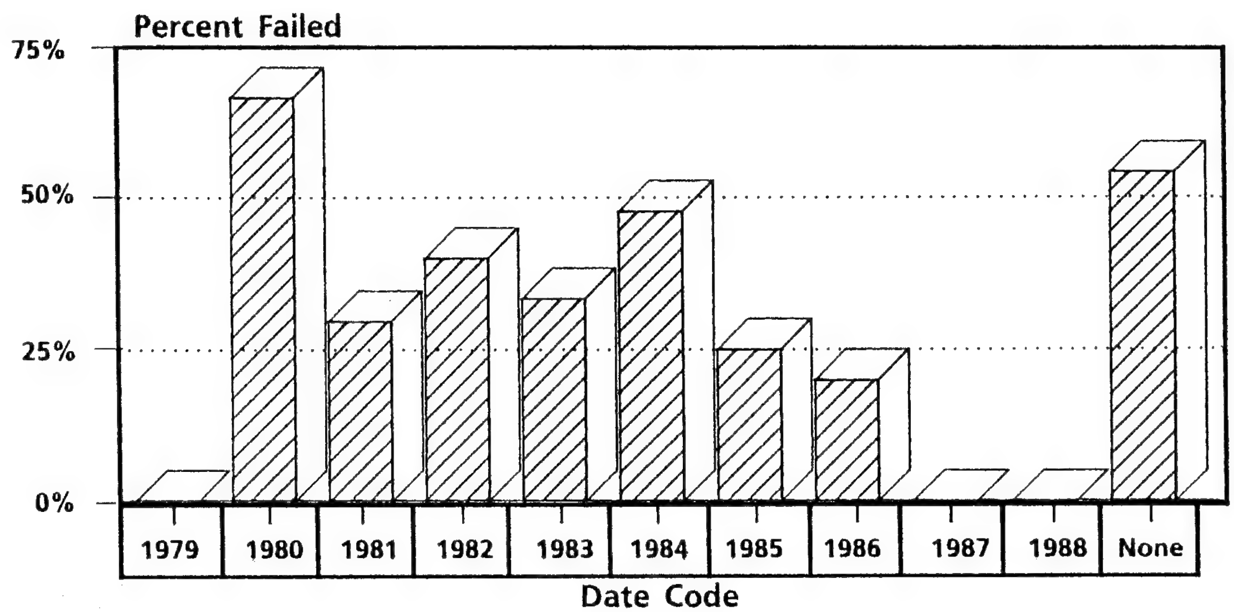
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (New & Used)
(Failure Code 11)



Percent Failed/Year	0%	66.7%	29.6%	40%	33.3%	47.7%	25%	20%	0%	0%	54.2%

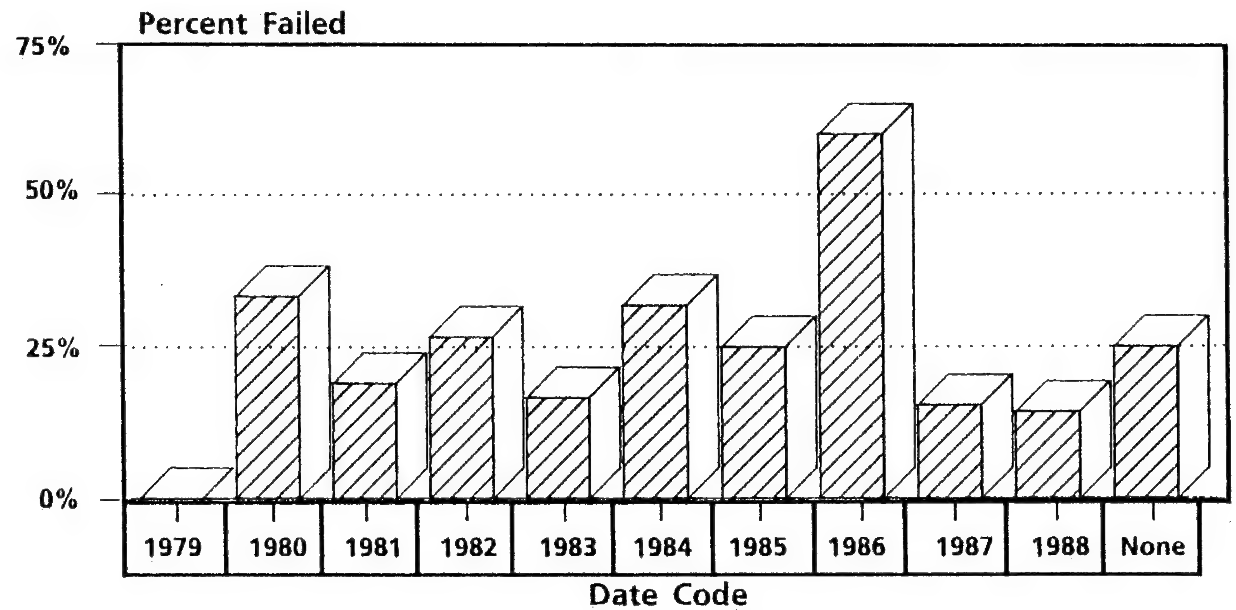
183 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (New & Used)
(Failure Code 12)



	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	None
Percent Failed/Year	0%	33.3%	19%	26.7%	16.7%	31.8%	25%	60%	15.4%	14.3%	25%

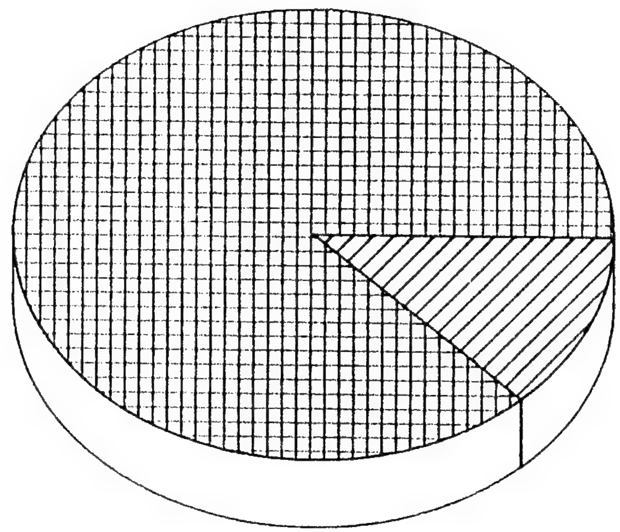
183 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

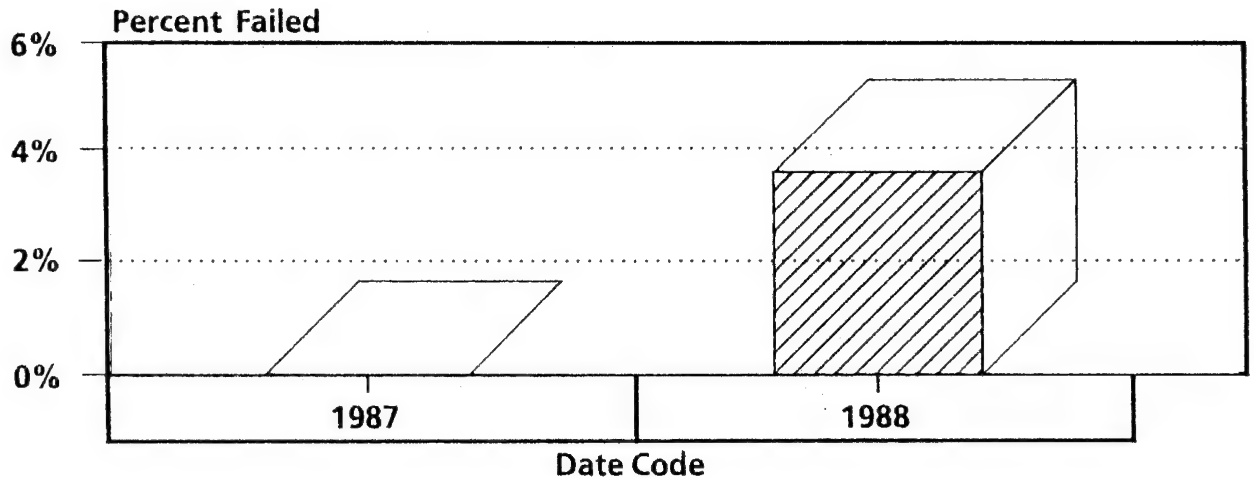
Screening Summary: Band 3 TMEC (New) TWTs



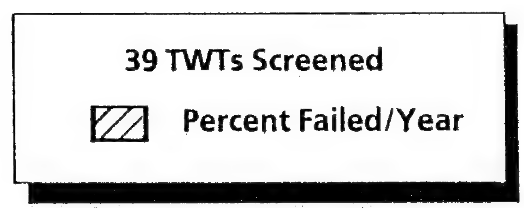
39 TWTs Tested

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 TMEC (New)
(Failure Code 1)



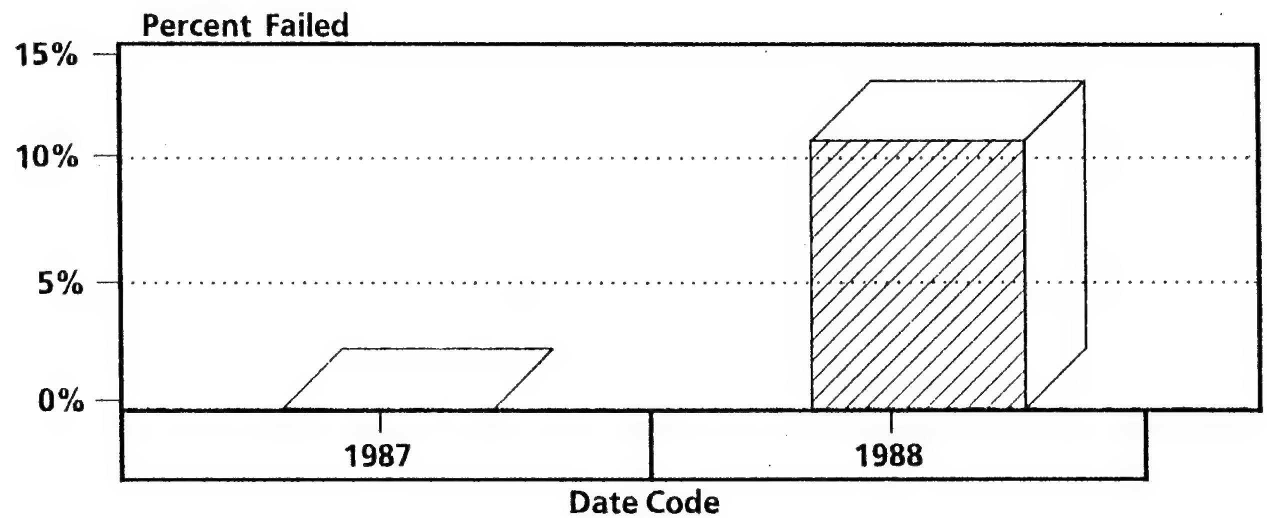
Percent Failed/Year	0%	3.6%



* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 TMEC (New)
(Failure Code 2)



Percent Failed/Year	0%	10.7%

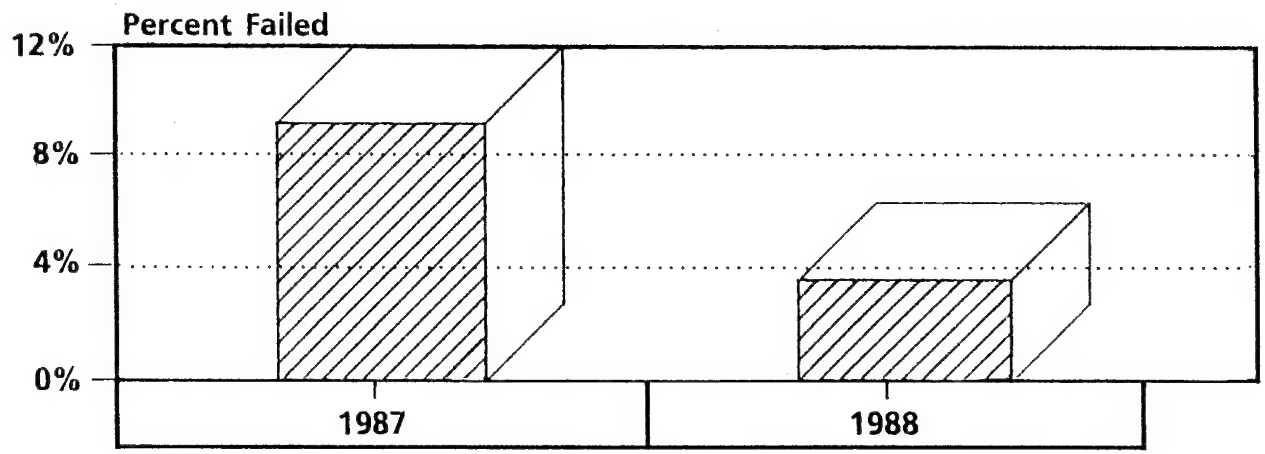
39 TWTs Screened

Percent Failed/Year

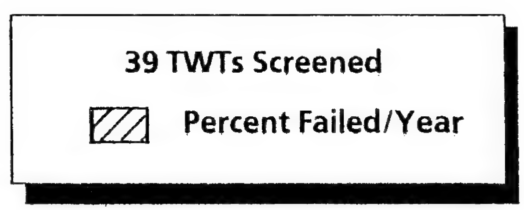
* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 TMEC (New)
(Failure Code 3)



Percent Failed/Year	9.1%	3.6%



* Each TWT may have more than one failure code

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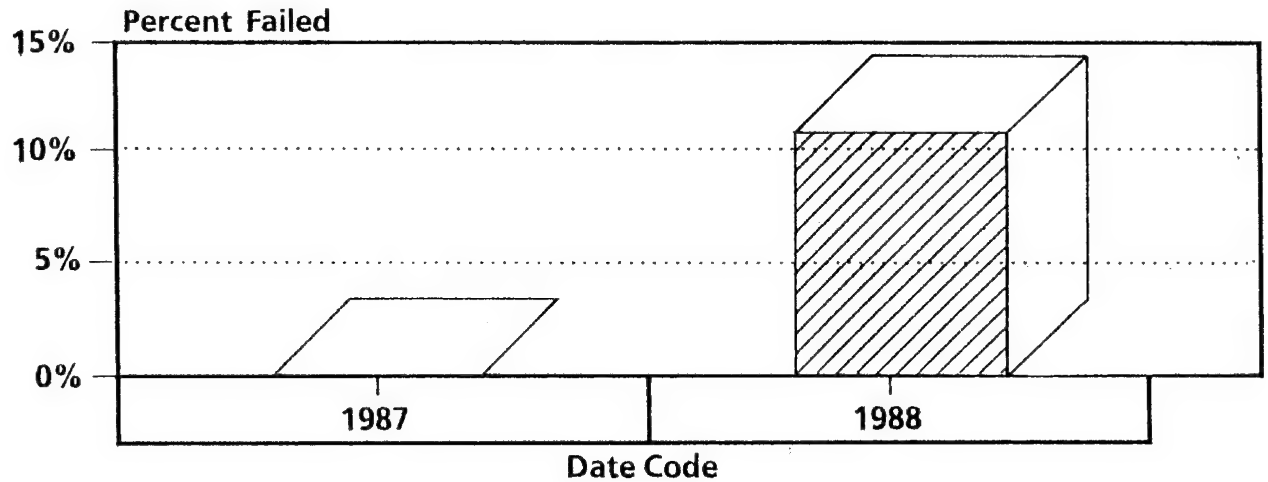
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 TMEC (New)
(Failure Code 10)



Percent Failed/Year	0%	10.7%

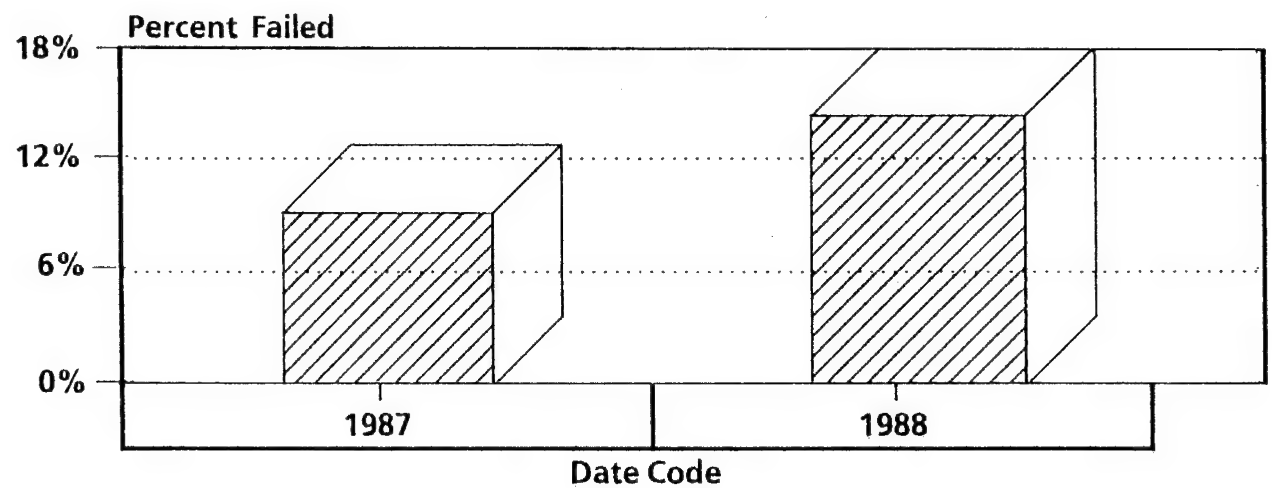
39 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 TMEC (New)
(Failure Code 12)

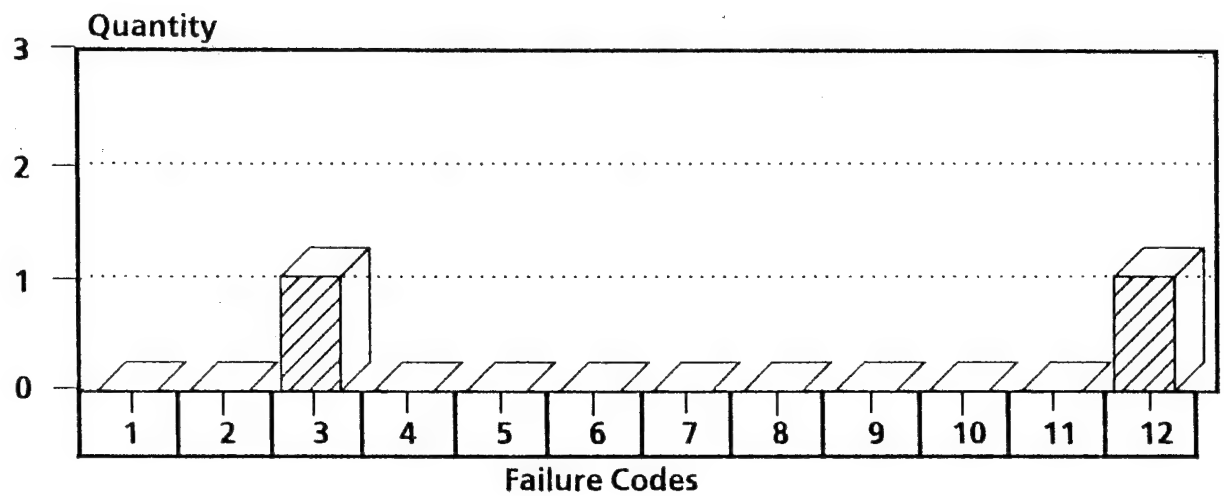


Percent Failed/Year	9.1%	14.3%

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 TMEC (New)
(1987 Date Code)



Total Failures	0	0	1	0	0	0	0	0	0	0	0	1

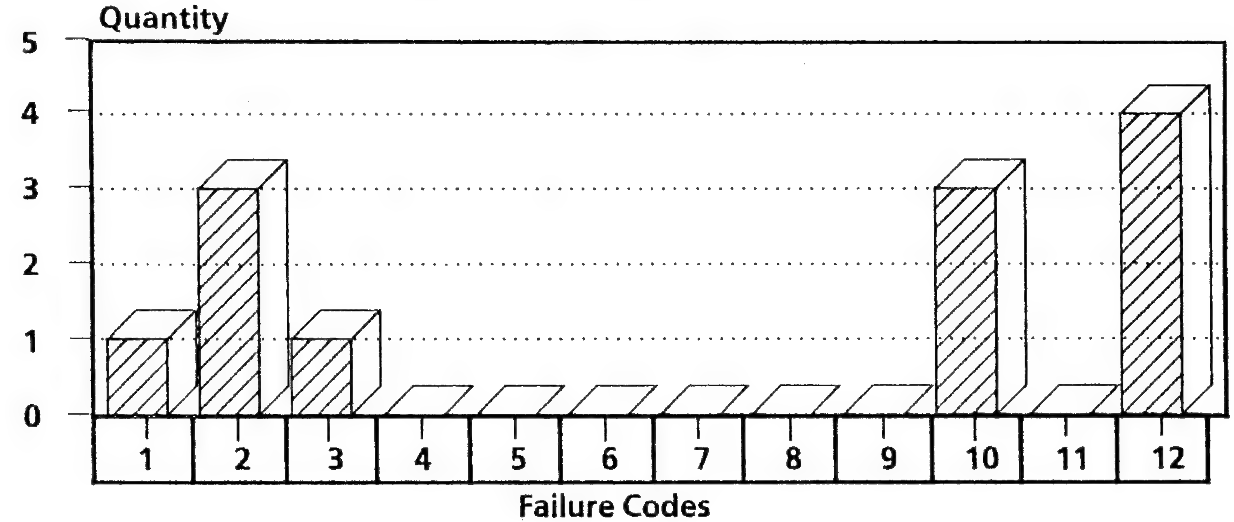
11 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 TMEC (New)
(1988 Date Code)



Total Failures	1	3	1	0	0	0	0	0	0	3	0	4

28 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
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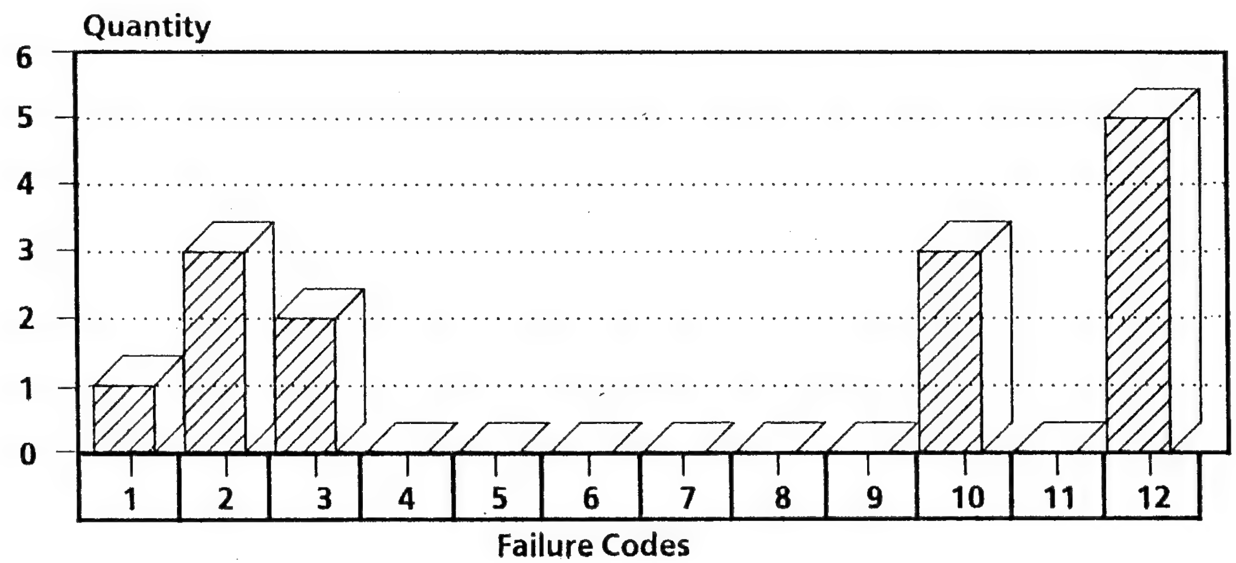
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 TMEC (New) by Failure Codes



Total Failures	1	3	2	0	0	0	0	0	0	3	0	5

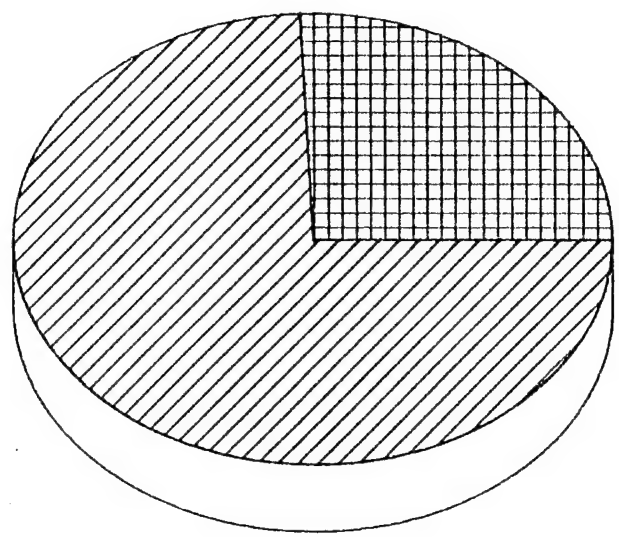
39 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

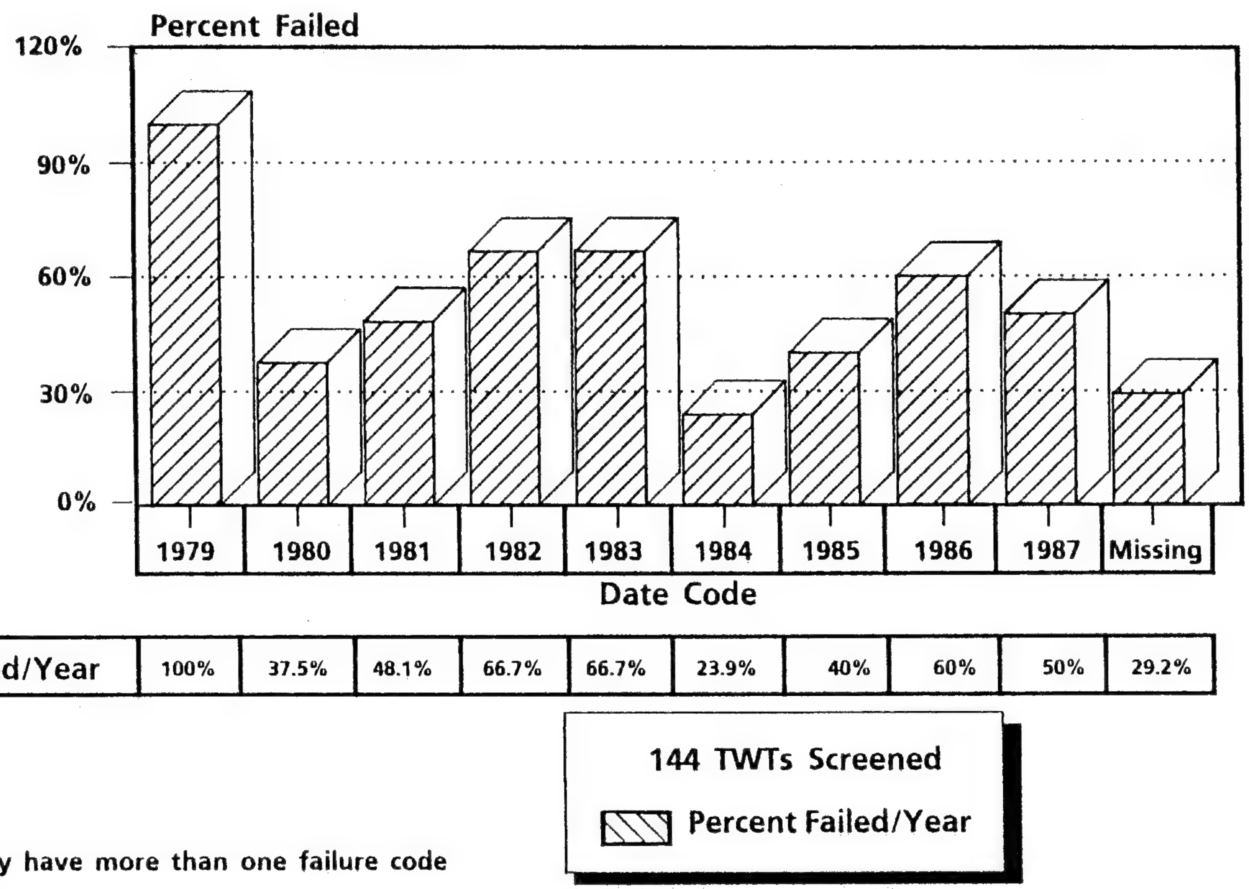
Screening Summary: Band 3 (Used)



144 TWTs Tested

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (Used)
(Failure Code 2)

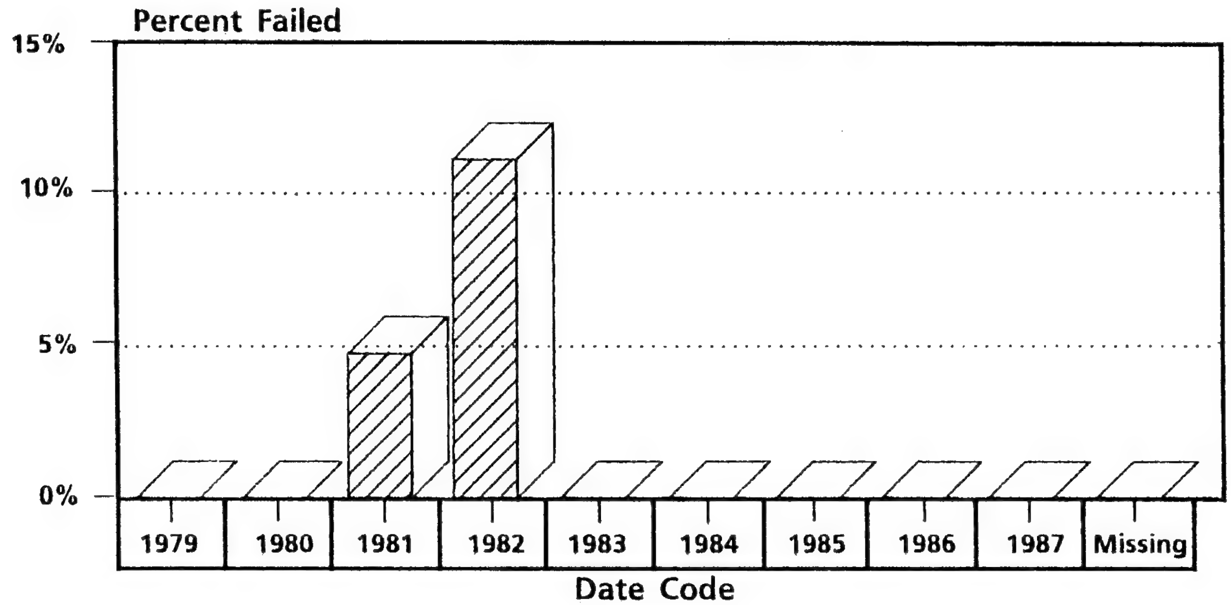


Percent Failed/Year	100%	37.5%	48.1%	66.7%	66.7%	23.9%	40%	60%	50%	29.2%

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (Used)
(Failure Code 3)



Percent Failed/Year	0%	0%	4.8%	11.1%	0%	0%	0%	0%	0%	0%

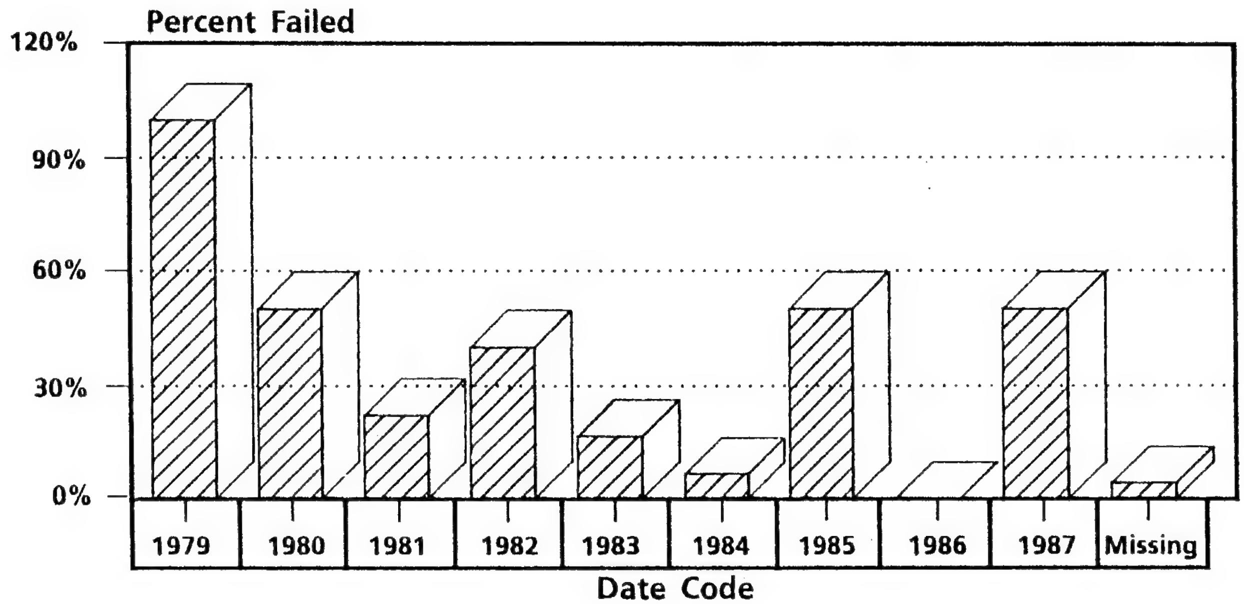
144 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (Used)
(Failure Code 4)



Percent Failed/Year	100%	50%	22.2%	40%	16.7%	6.5%	50%	0%	50%	4.2%

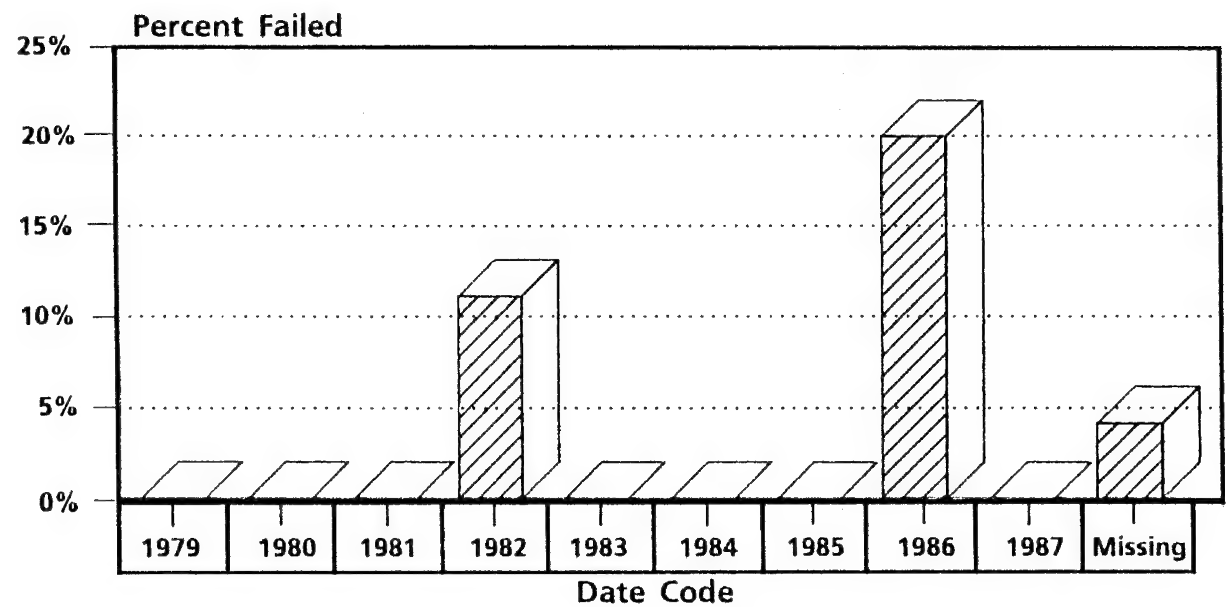
144 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (Used)
(Failure Code 5)



	1979	1980	1981	1982	1983	1984	1985	1986	1987	Missing
Percent Failed/Year	0%	0%	0%	11.1%	0%	0%	0%	20%	0%	4.2%

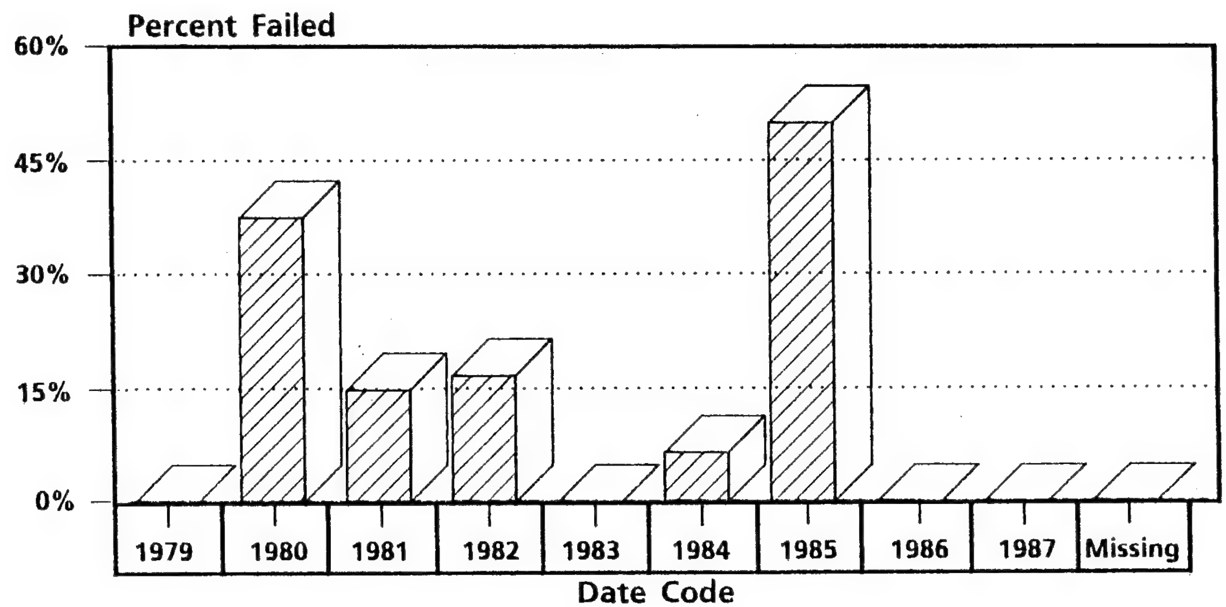
144 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (Used)
(Failure Code 6)



Percent Failed/Year	0%	37.5%	14.8%	16.7%	0%	6.5%	50%	0%	0%	0%

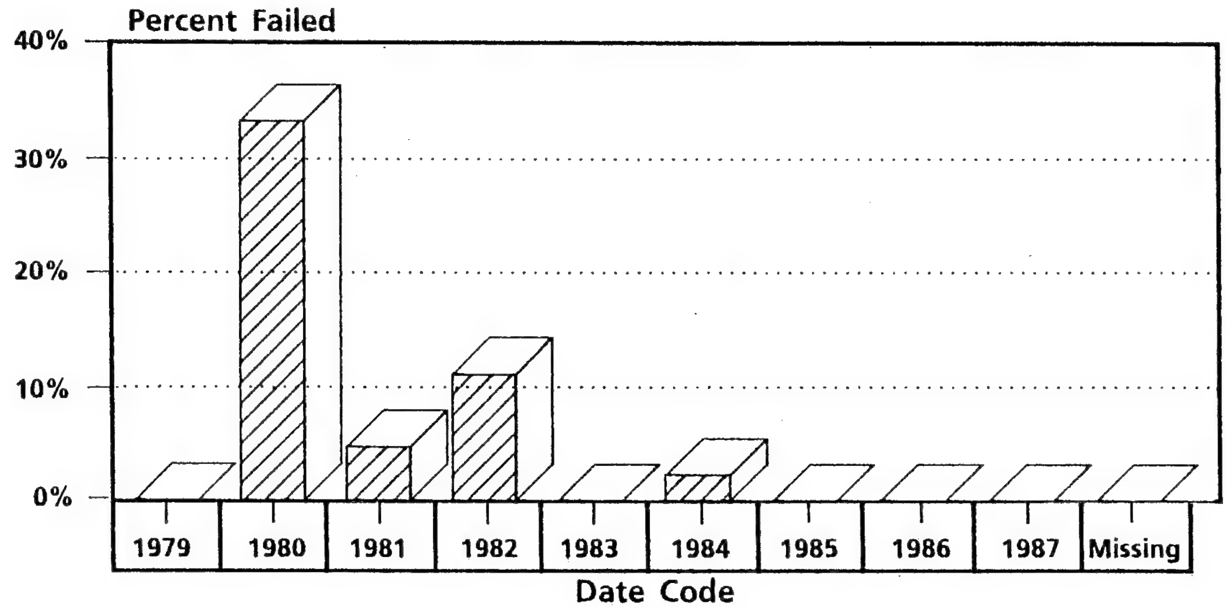
144 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (Used)
(Failure Code 7)



Percent Failed/Year	0%	33.3%	4.8%	11.1%	0%	2.3%	0%	0%	0%	0%

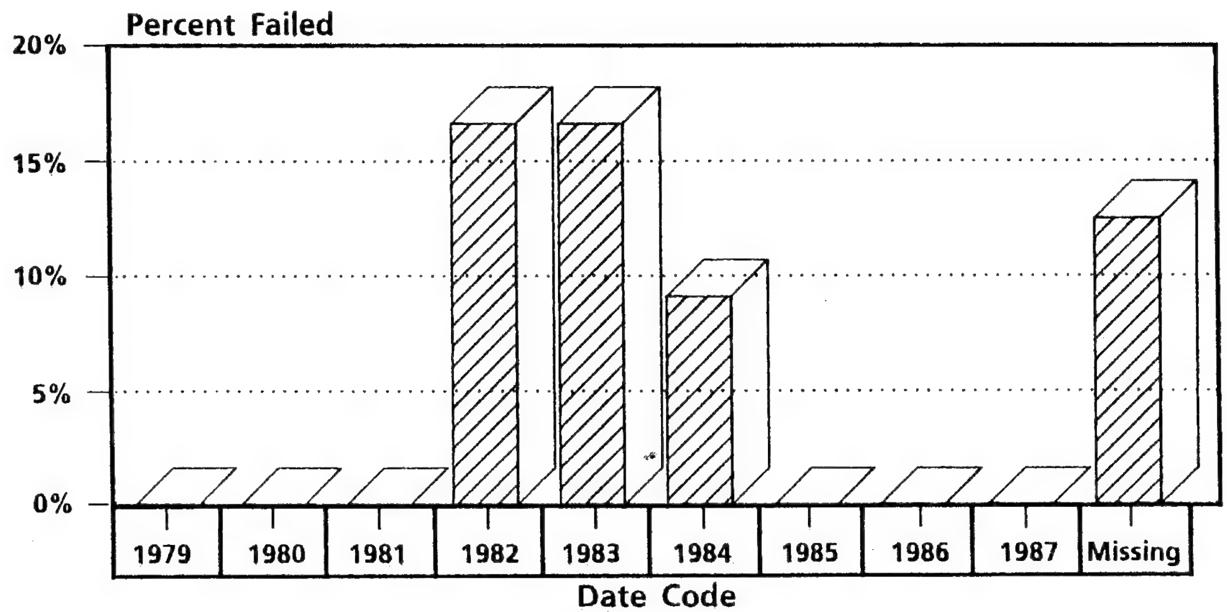
144 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (Used)
(Failure Code 8)



	1979	1980	1981	1982	1983	1984	1985	1986	1987	Missing
Percent Failed/Year	0%	0%	0%	16.7%	16.7%	9.1%	0%	0%	0%	12.5%

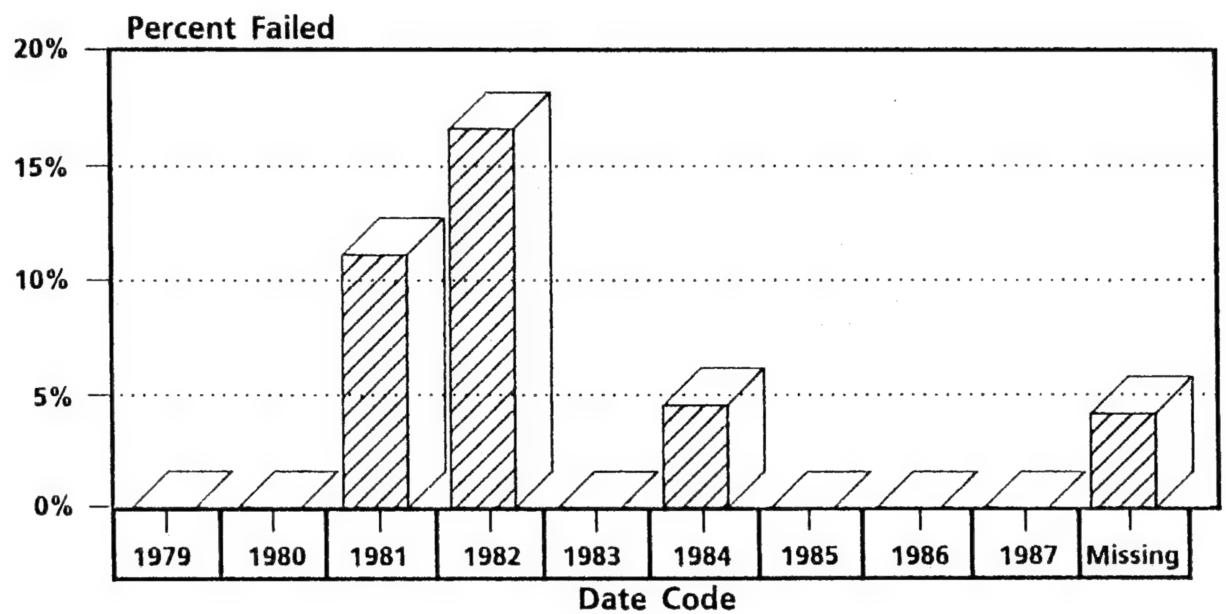
144 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (Used)
(Failure Code 10)



Percent Failed/Year	0%	0%	11.1%	16.7%	0%	4.5%	0%	0%	0%	4.2%

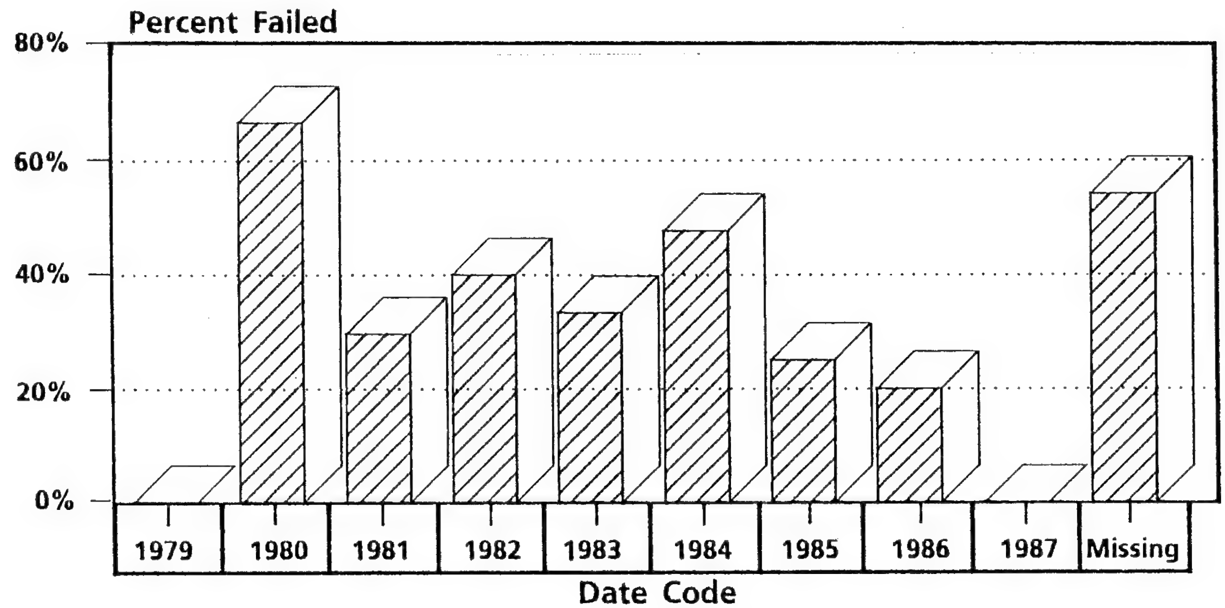
144 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (Used)
(Failure Code 11)



Percent Failed/Year	0%	66.7%	29.6%	40%	33.3%	47.7%	25%	20%	0%	54.2%

144 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

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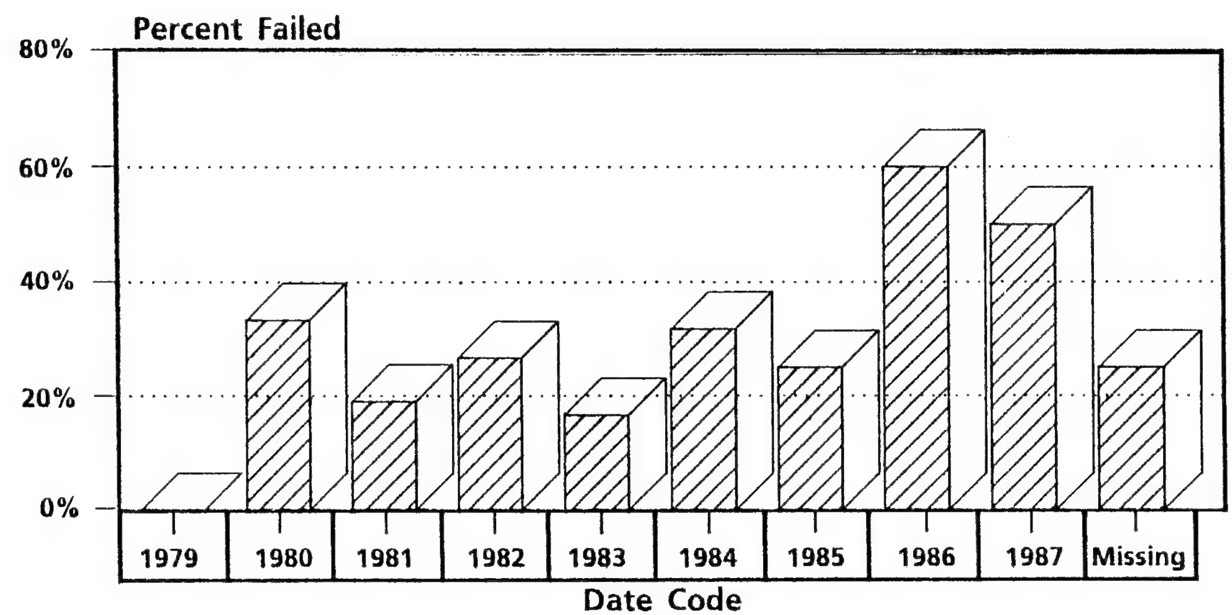
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (Used)
(Failure Code 12)



Percent Failed/Year	0%	33.3%	19%	26.7%	16.7%	31.8%	25%	60%	50%	25%

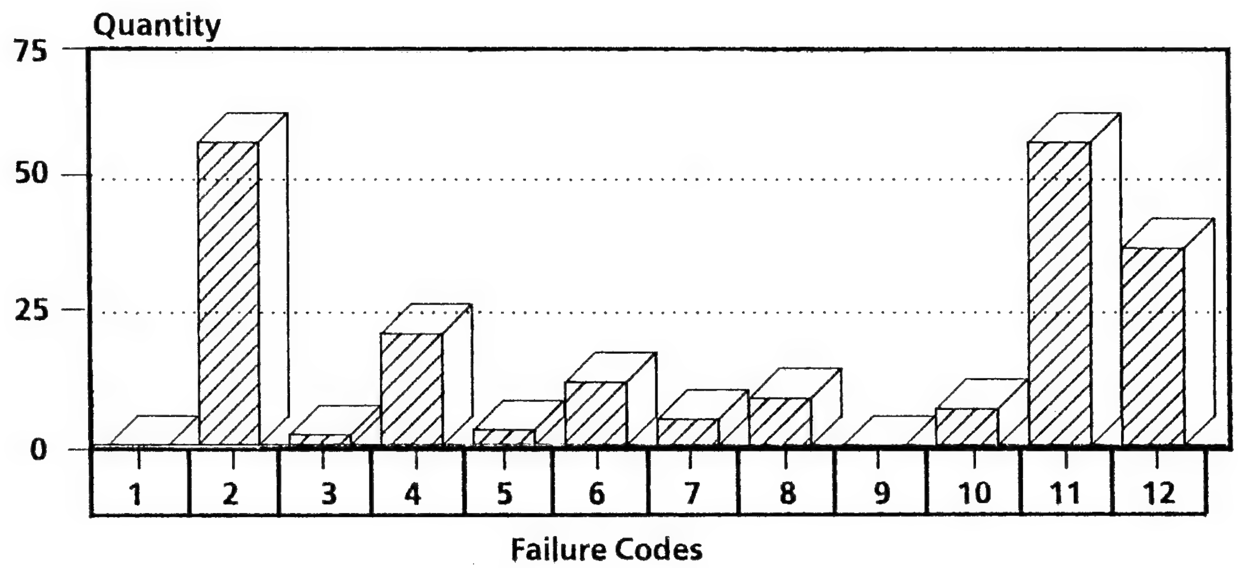
144 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 (Used) by Failure Codes



Total Failures	0	57	2	21	3	12	5	9	0	7	57	37

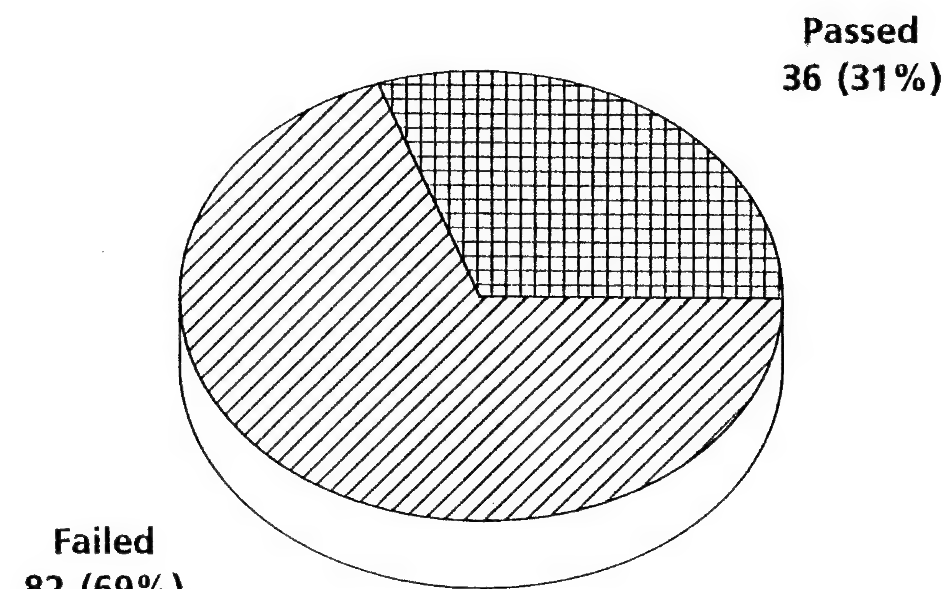
144 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

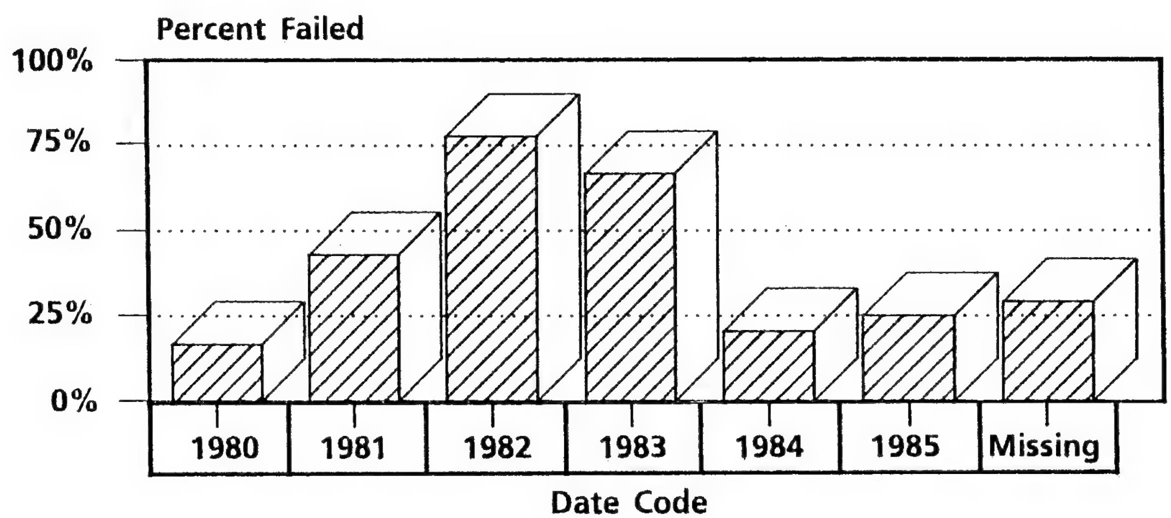
Screening Summary: Band 3 Varian (Used)



118 TWTs Tested

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(Failure Code 2)



Percent Failed/Year	16.7%	42.9%	77.8%	66.7%	20.5%	25%	29.2%

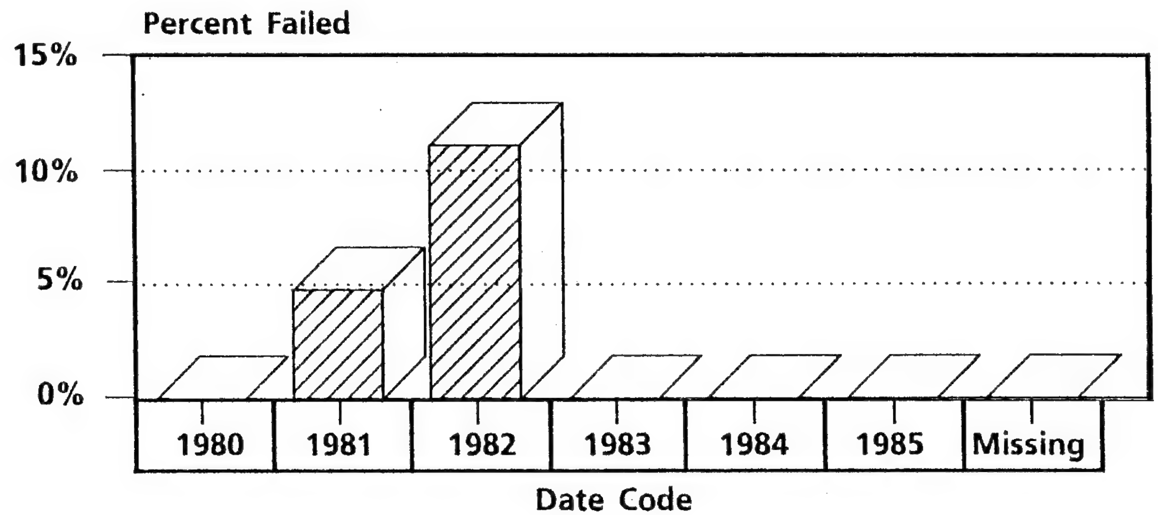
118 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(Failure Code 3)



Percent Failed/Year	0%	4.8%	11.1%	0%	0%	0%	0%

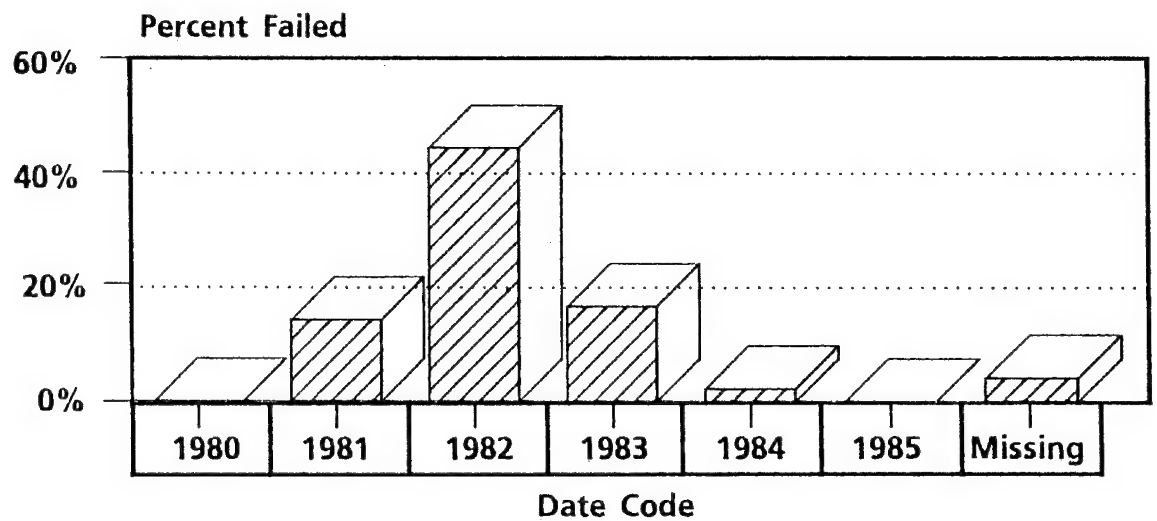
118 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(Failure Code 4)



Percent Failed/Year	0%	14.3%	44.4%	16.7%	2.3%	0%	4.2%

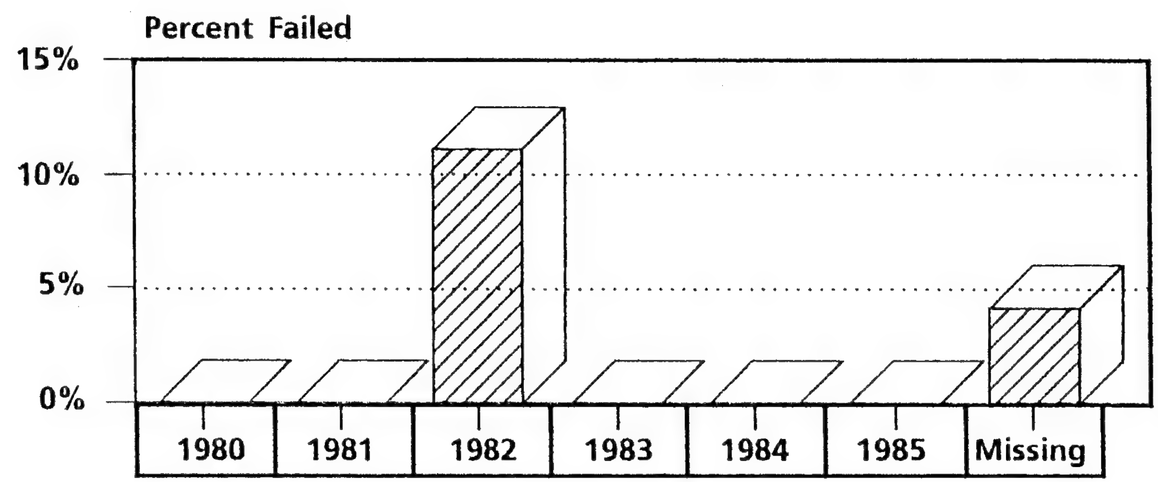
118 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(Failure Code 5)



Percent Failed/Year	0%	0%	11.1%	0%	0%	0%	4.2%

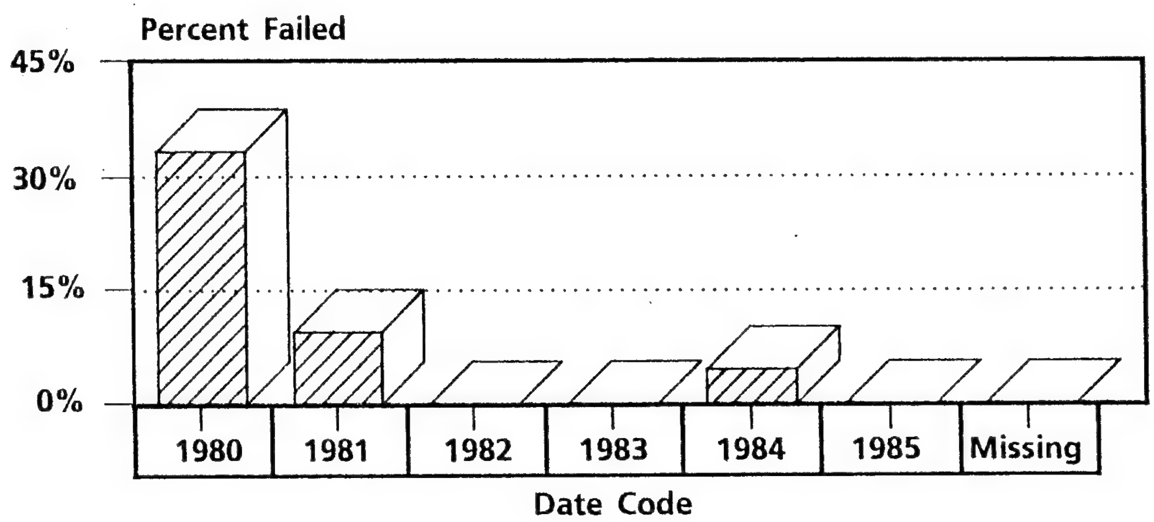
118 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(Failure Code 6)



Percent Failed/Year	33.3%	9.5%	0%	0%	4.5%	0%	0%

118 TWTs Screened

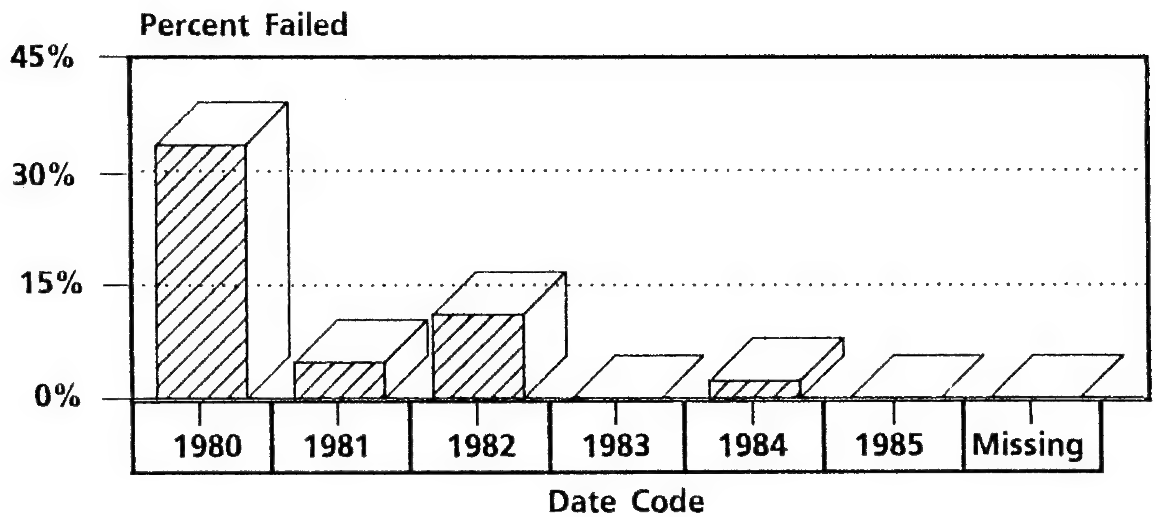
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(Failure Code 7)



Percent Failed/Year	33.3%	4.8%	11.1%	0%	2.3%	0%	0%

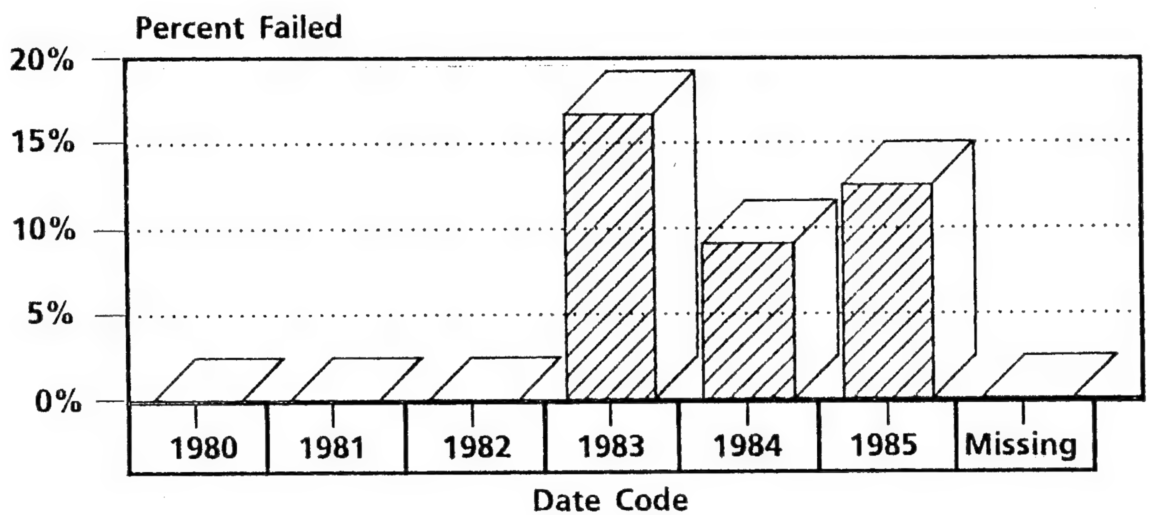
118 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(Failure Code 8)



Percent Failed/Year	0%	0%	0%	16.7%	9.1%	12.5%	0%

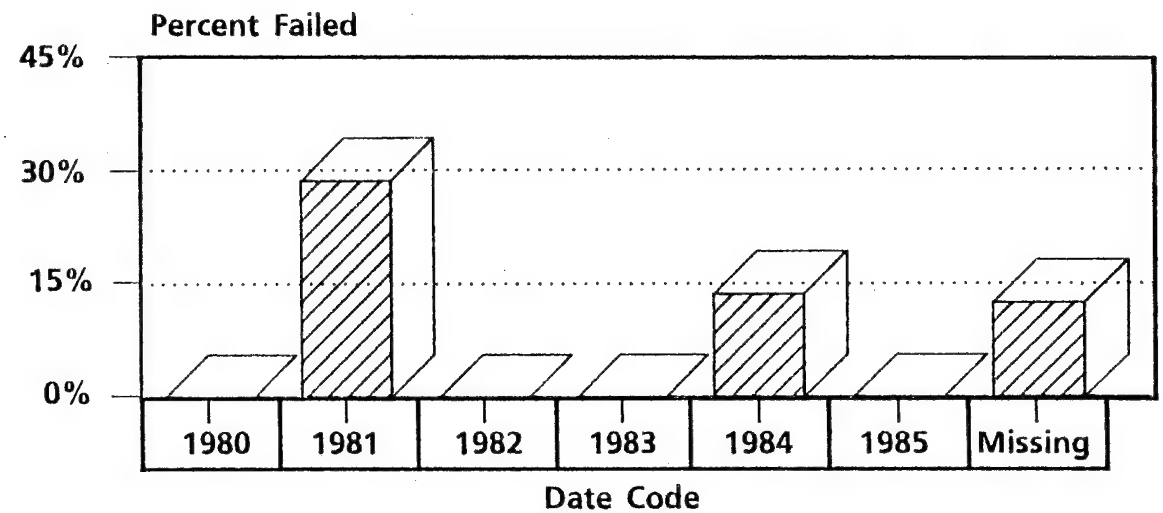
118 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(Failure Code 10)



Percent Failed/Year	0%	9.5%	0%	0%	4.5%	0%	4.2%

118 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
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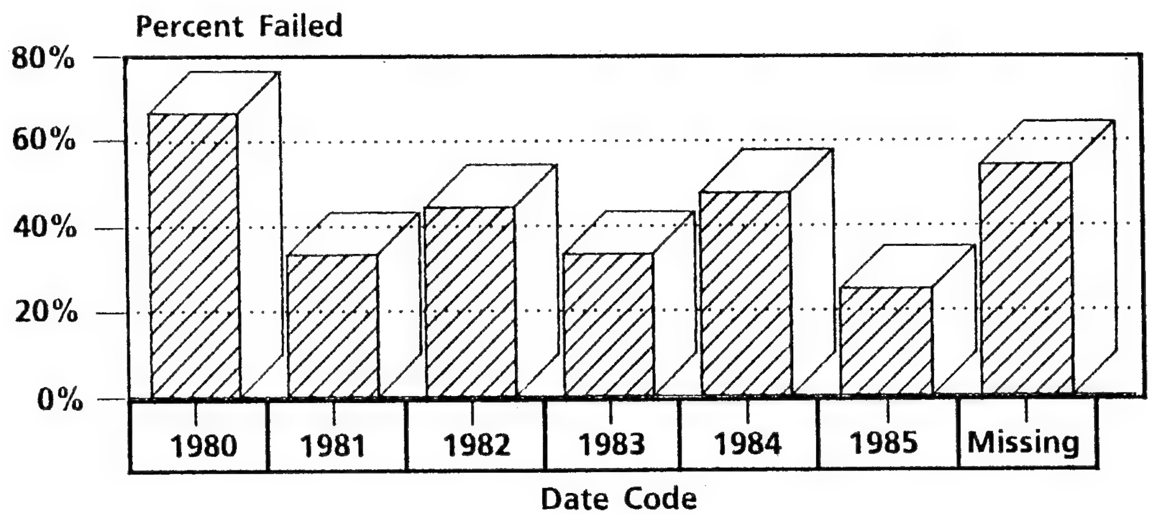
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(Failure Code 11)



Percent Failed/Year	66.7%	33.3%	44.4%	33.3%	47.7%	25%	54.2%

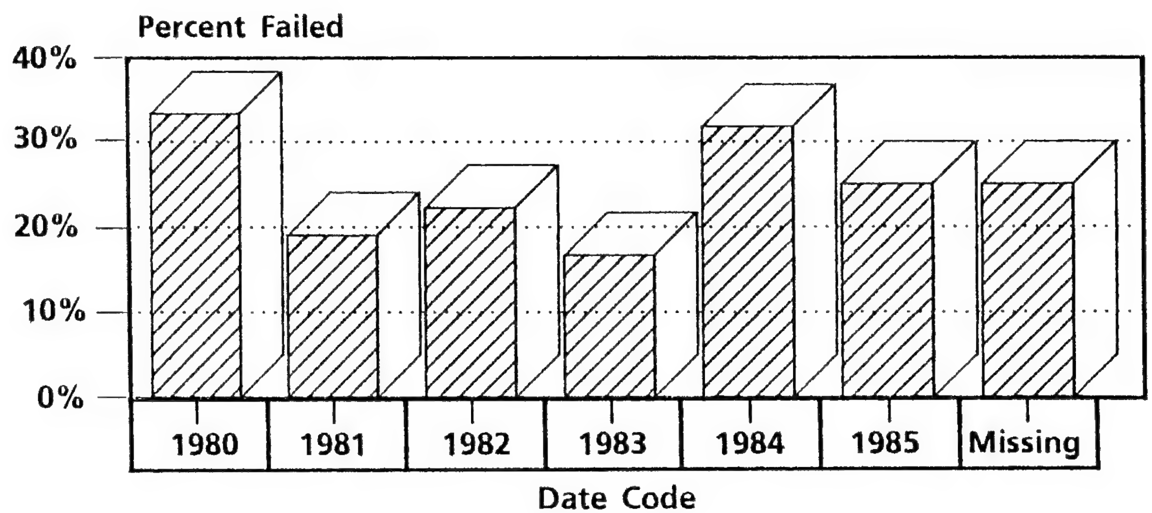
118 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(Failure Code 12)



	1980	1981	1982	1983	1984	1985	Missing
Percent Failed/Year	33.3%	19%	22.2%	16.7%	31.8%	25%	25%

118 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
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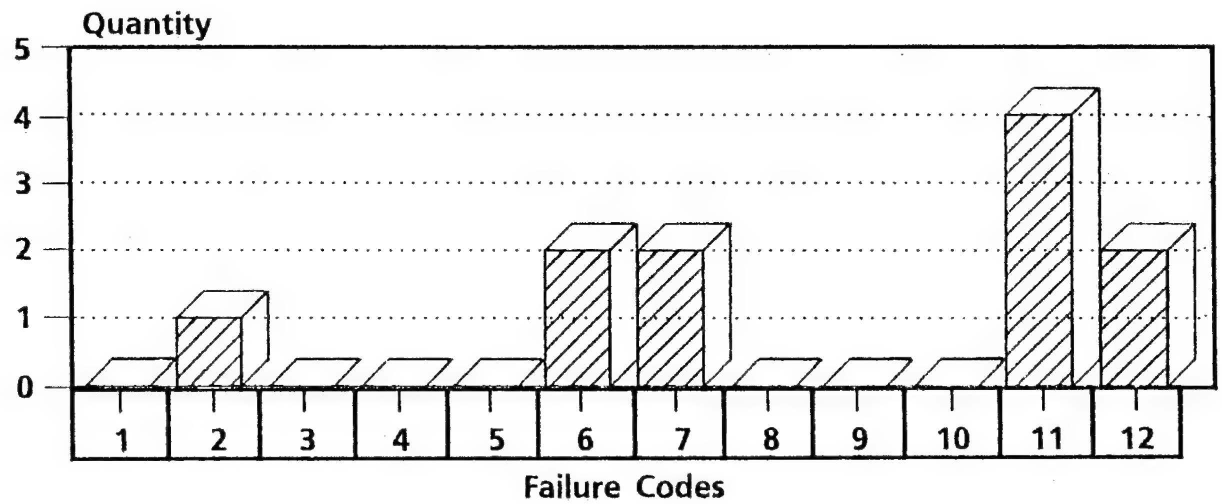
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(1980 Date Code)



Total Failures	0	1	0	0	0	2	2	0	0	0	4	2

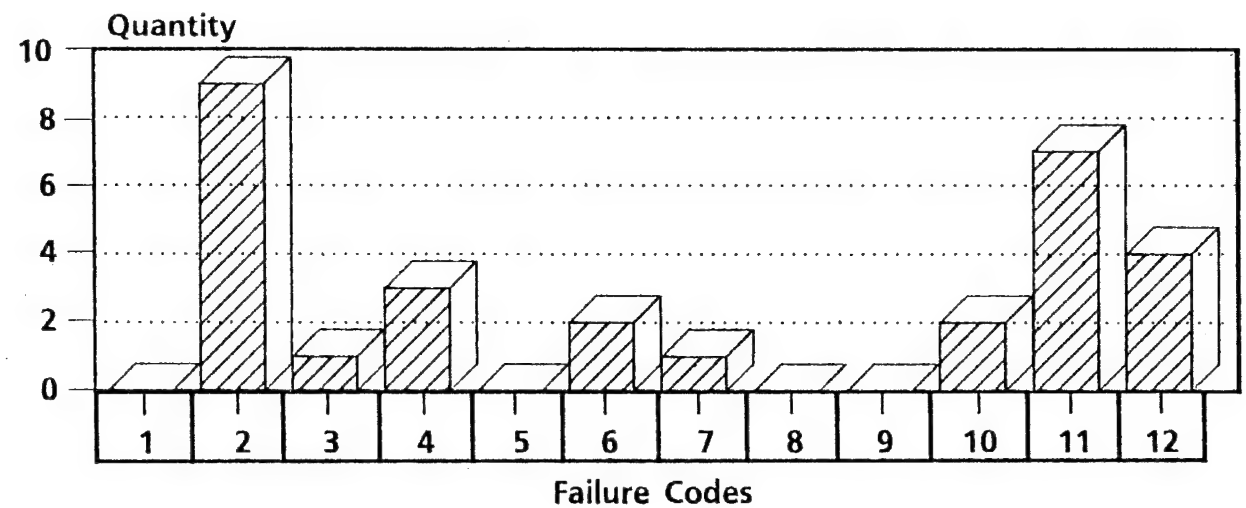
6 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(1981 Date Code)



Total Failures	0	9	1	3	0	2	1	0	0	2	7	4

21 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
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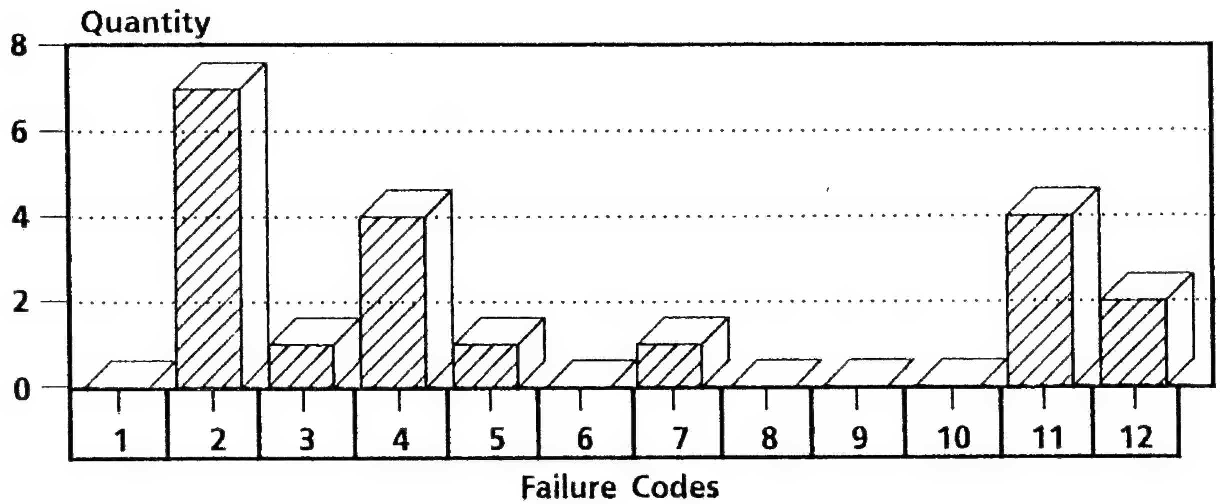
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(1982 Date Code)



Total Failures	0	7	1	4	1	0	1	0	0	0	4	2

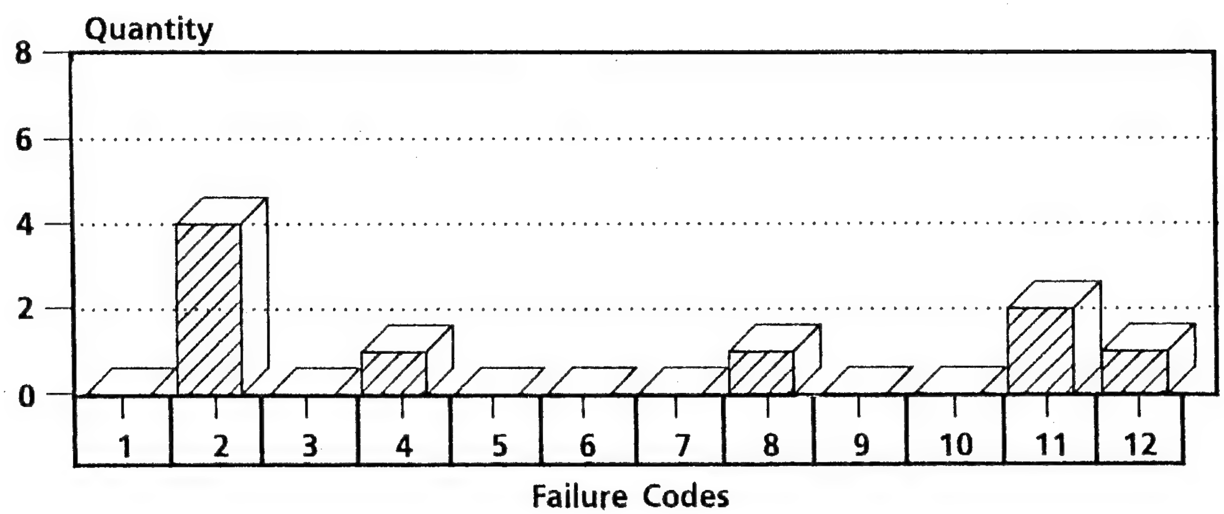
9 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(1983 Date Code)



Total Failures	0	4	0	1	0	0	0	1	0	0	2	1

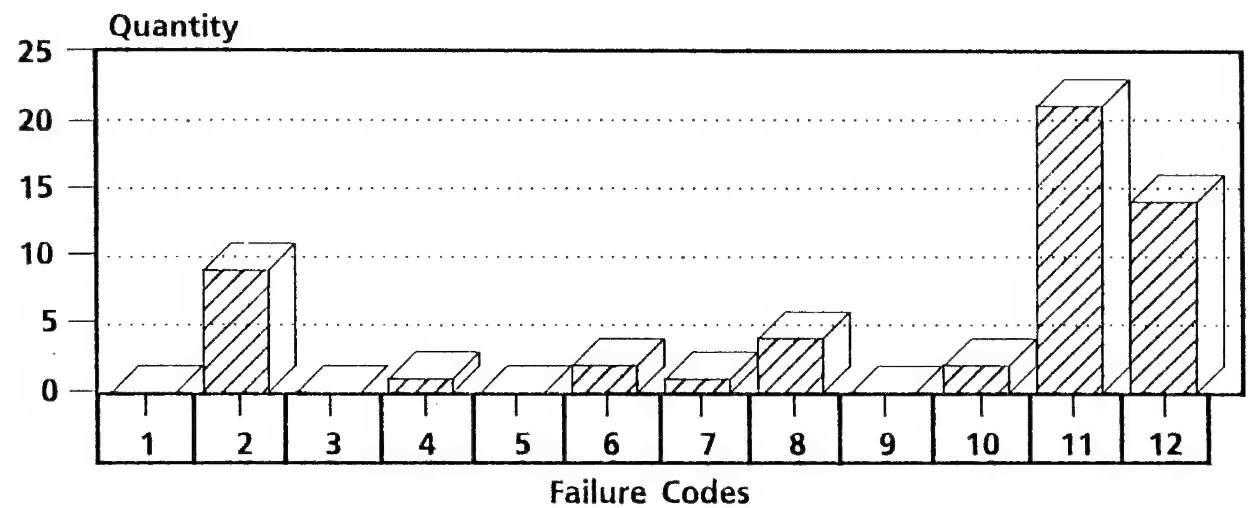
6 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(1984 Date Code)



Total Failures	0	9	0	1	0	2	1	4	0	2	21	14

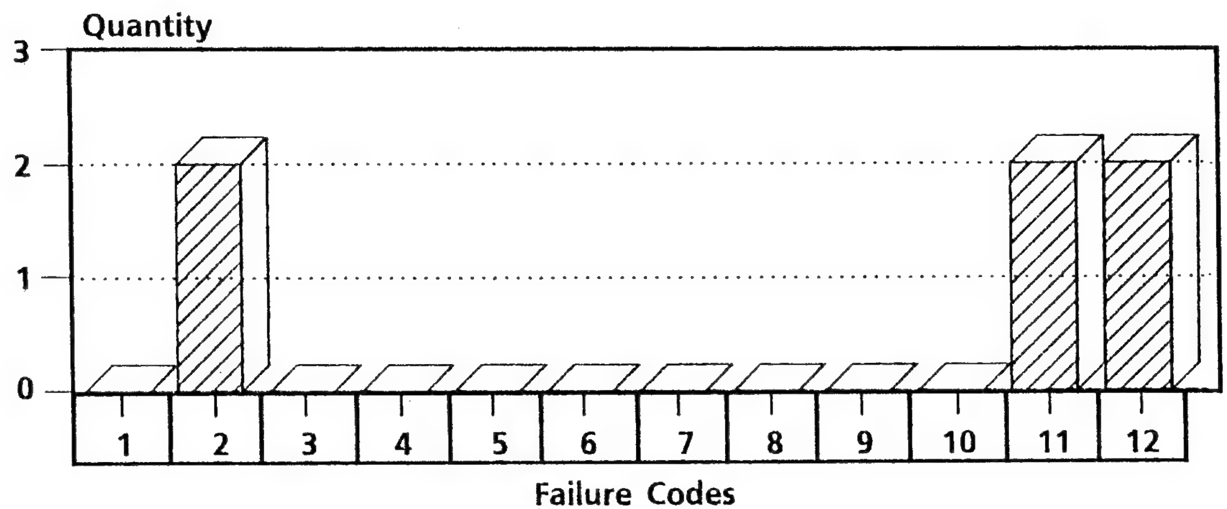
44 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(1985 Date Code)



Total Failures	0	2	0	0	0	0	0	0	0	0	2	2

8 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
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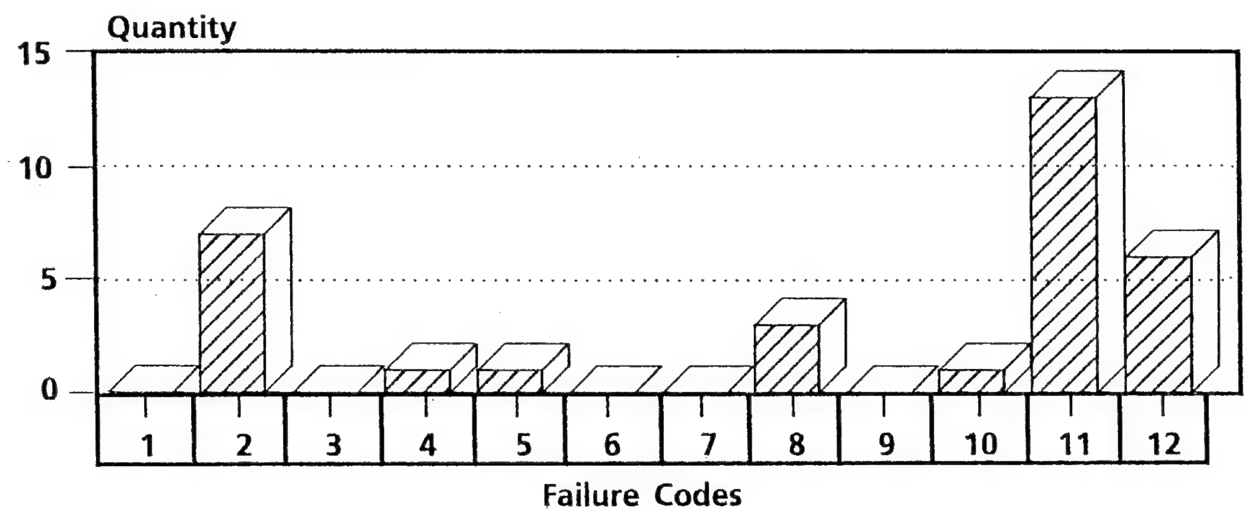
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used)
(Missing Date Code)

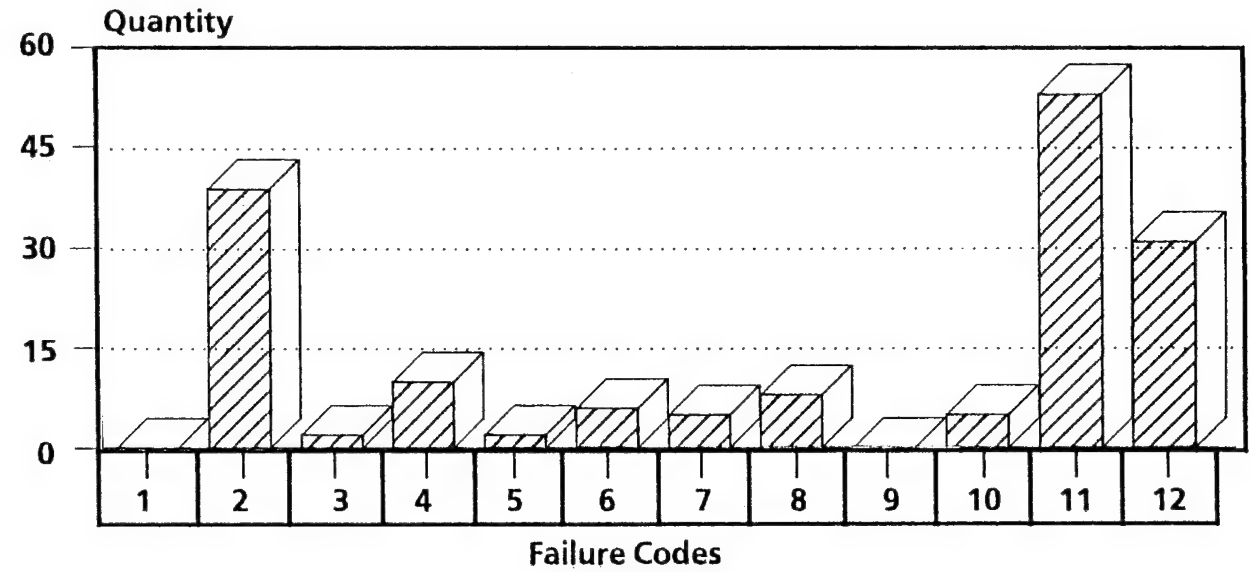


Total Failures	0	7	0	1	1	0	0	3	0	1	13	6

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Varian (Used) TWTs by Failure Codes



Total Failures	0	39	2	10	2	6	5	8	0	5	53	31

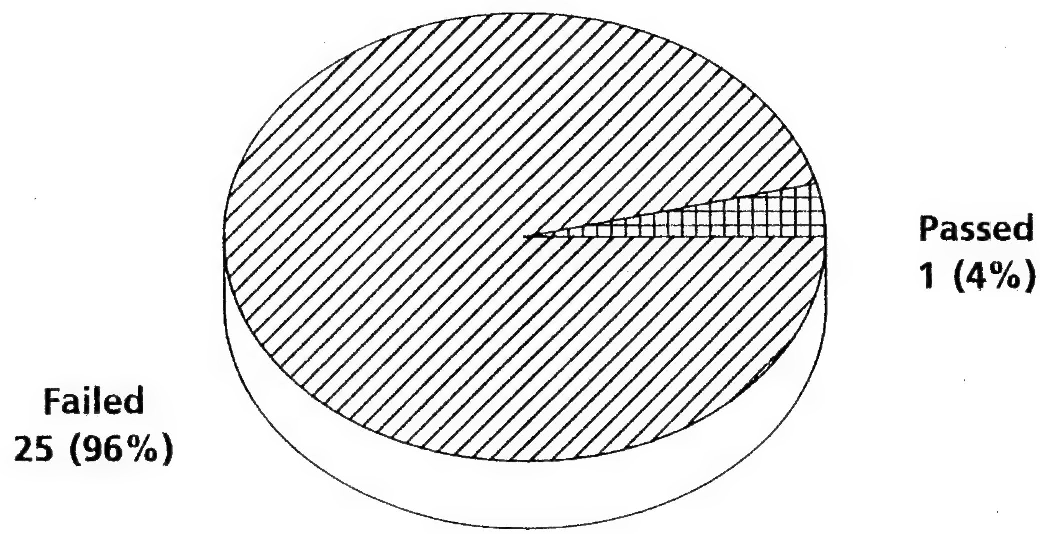
118 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

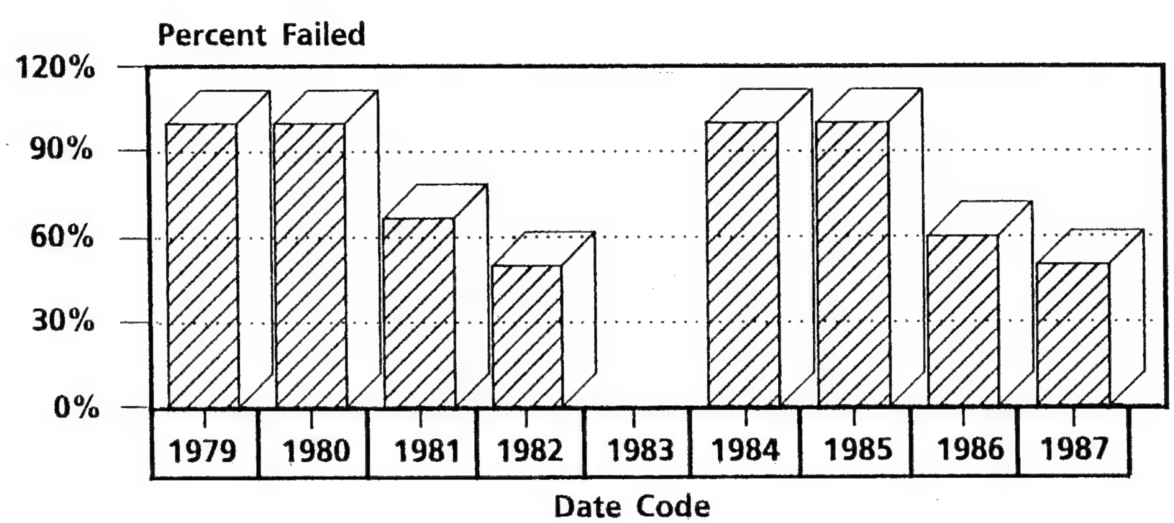
Screening Summary: Band 3 Litton (Used)



26 TWTs Tested

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 2)



Percent Failed/Year	100%	100%	66.7%	50%	N/A	100%	100%	60%	50%

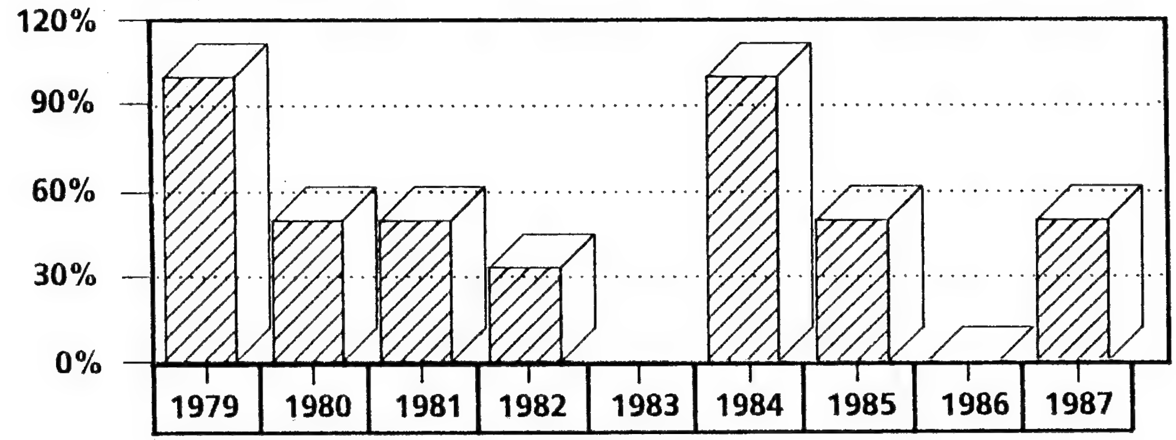
26 TWTs Screened

Percent Failed/Year

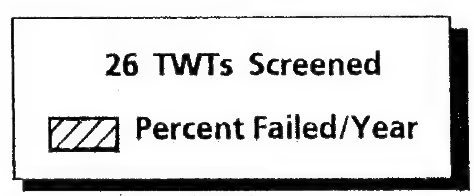
* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 4)



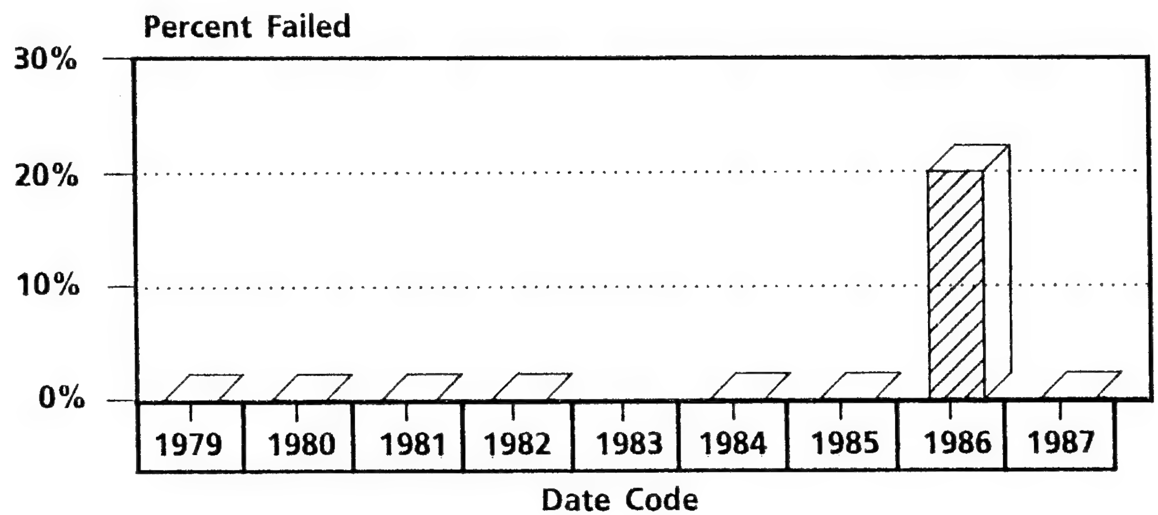
Percent Failed/Year	100%	50%	50%	33.3%	N/A	100%	50%	0%	50%



* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 5)



	1979	1980	1981	1982	1983	1984	1985	1986	1987
Percent Failed/Year	0%	0%	0%	0%	N/A	0%	0%	20.0%	0%

26 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
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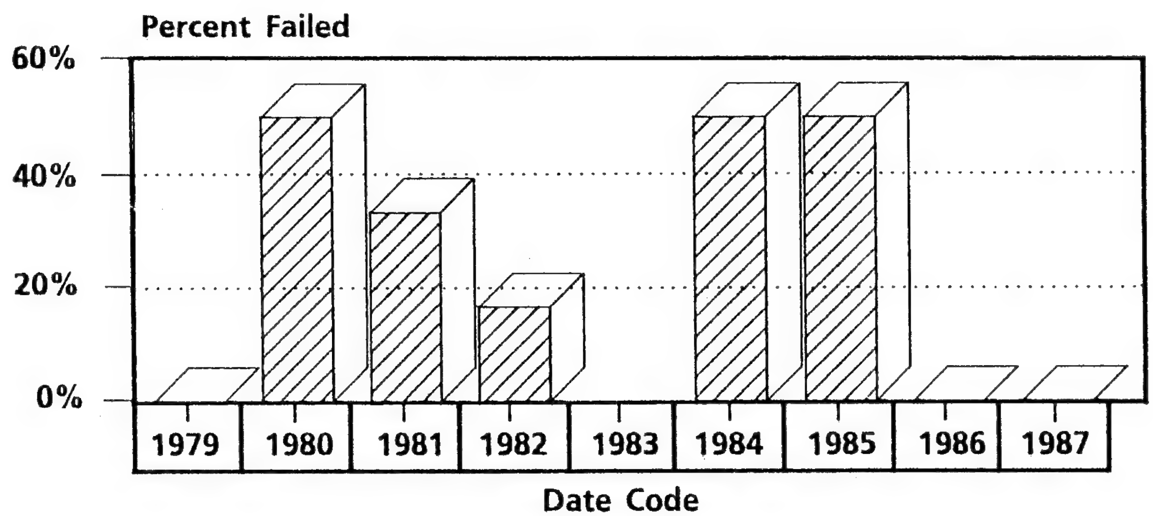
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 6)



Percent Failed/Year	0%	50%	33.3%	16.7%	N/A	50%	50%	0%	0%

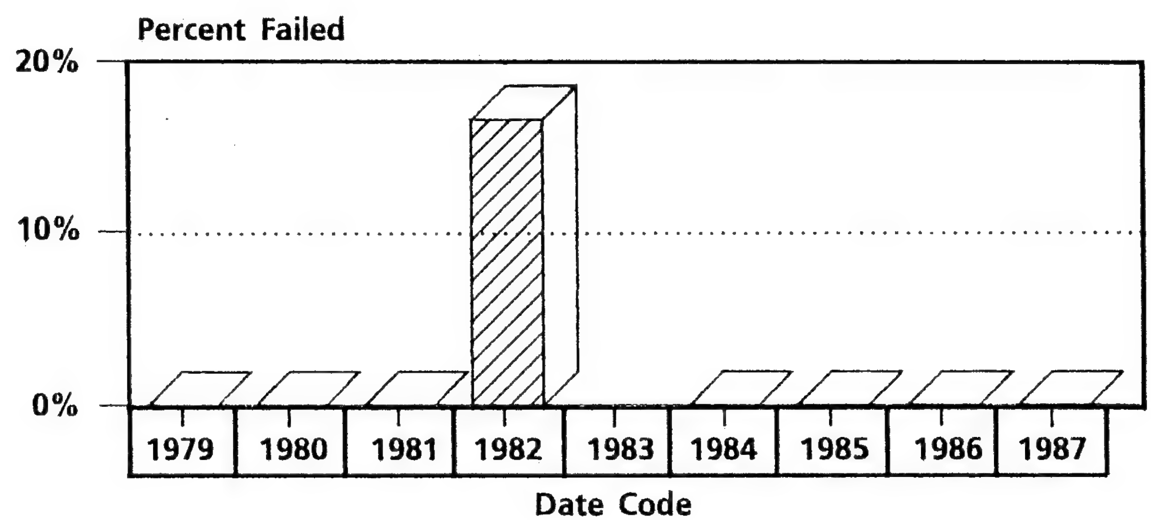
26 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 8)



Percent Failed/Year	0%	0%	0%	16.7%	N/A	0%	0%	0%	0%

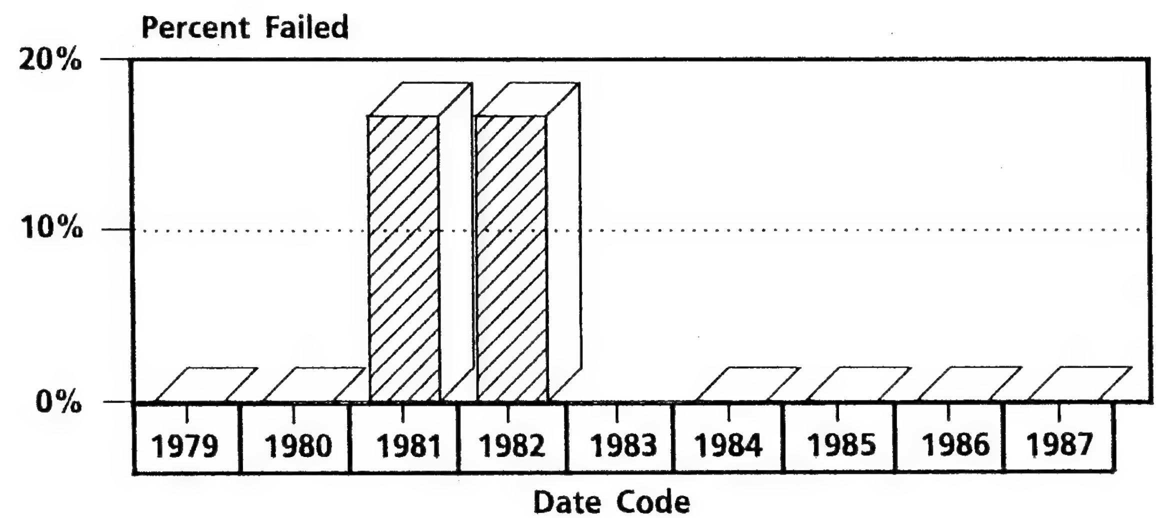
26 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 10)



	1979	1980	1981	1982	1983	1984	1985	1986	1987
Percent Failed/Year	0%	0%	16.7%	16.7%	N/A	0%	0%	0%	0%

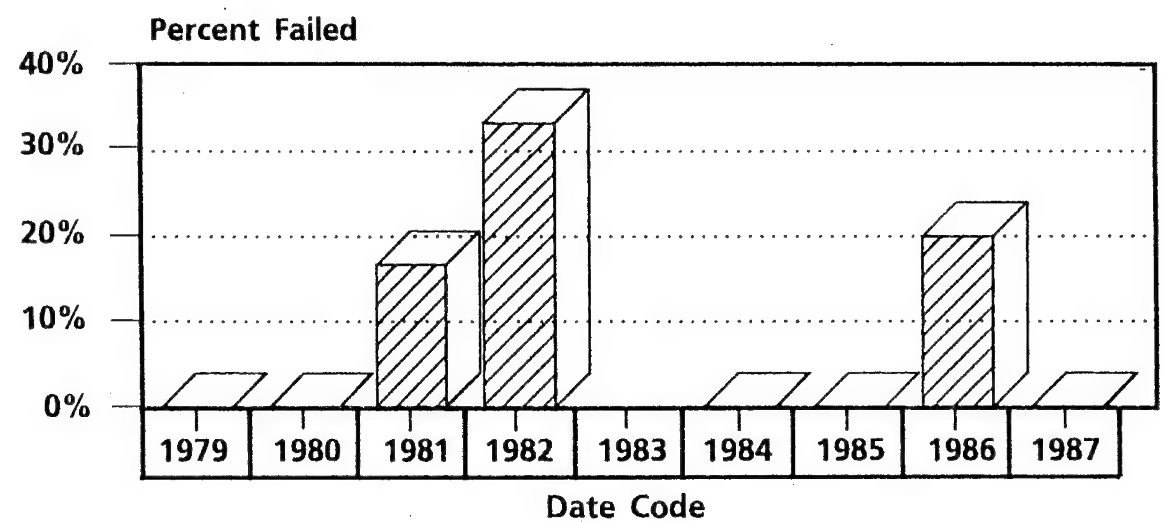
26 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 11)



Percent Failed/Year	0%	0%	16.7%	33.3%	N/A	0%	0%	20%	0%

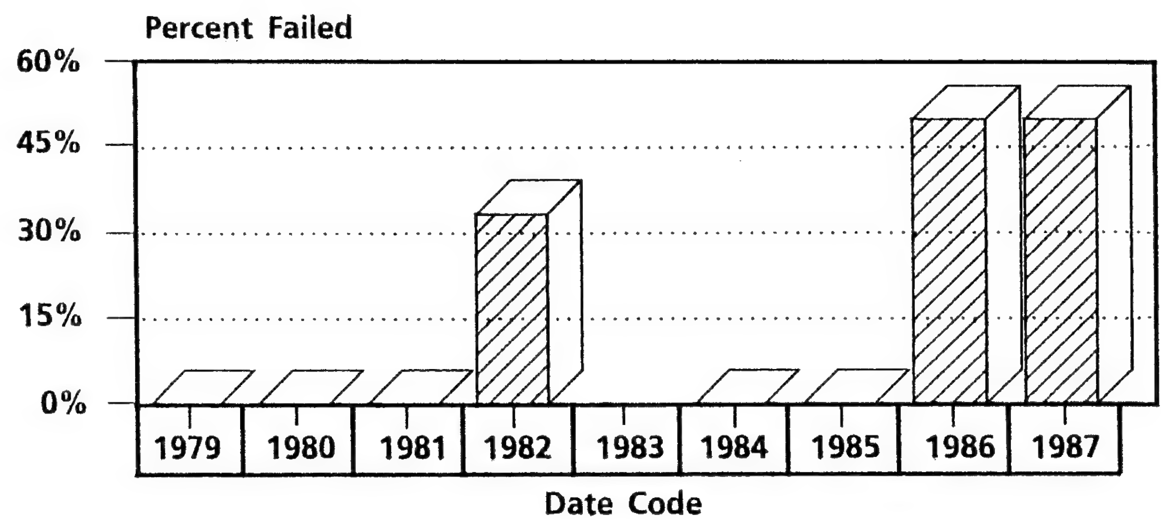
26 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 12)



Percent Failed/Year	0%	0%	0%	33.3%	N/A	0%	0%	50%	50%

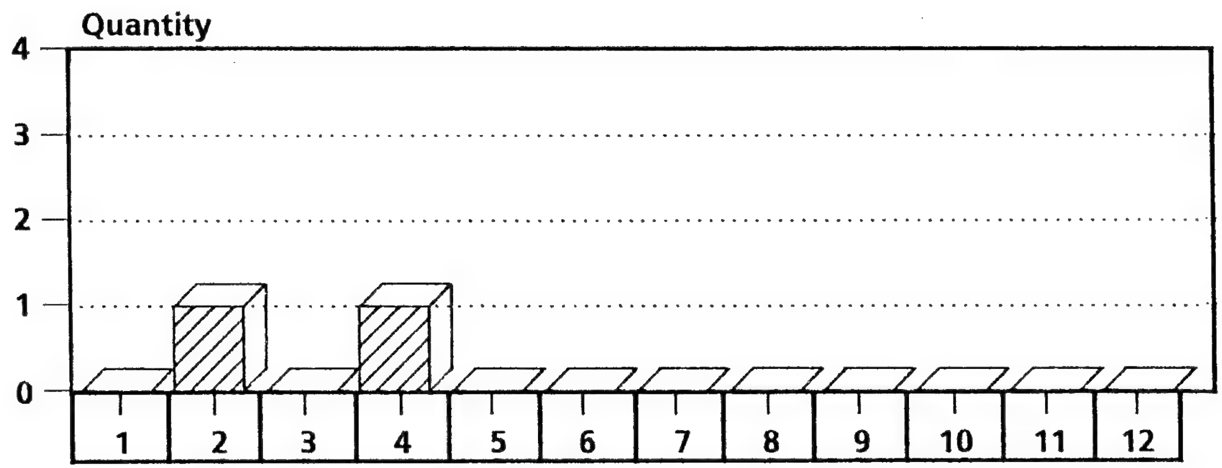
26 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(1979 Date Code)



	1	2	3	4	5	6	7	8	9	10	11	12
Total Failures	0	1	0	1	0	0	0	0	0	0	0	0

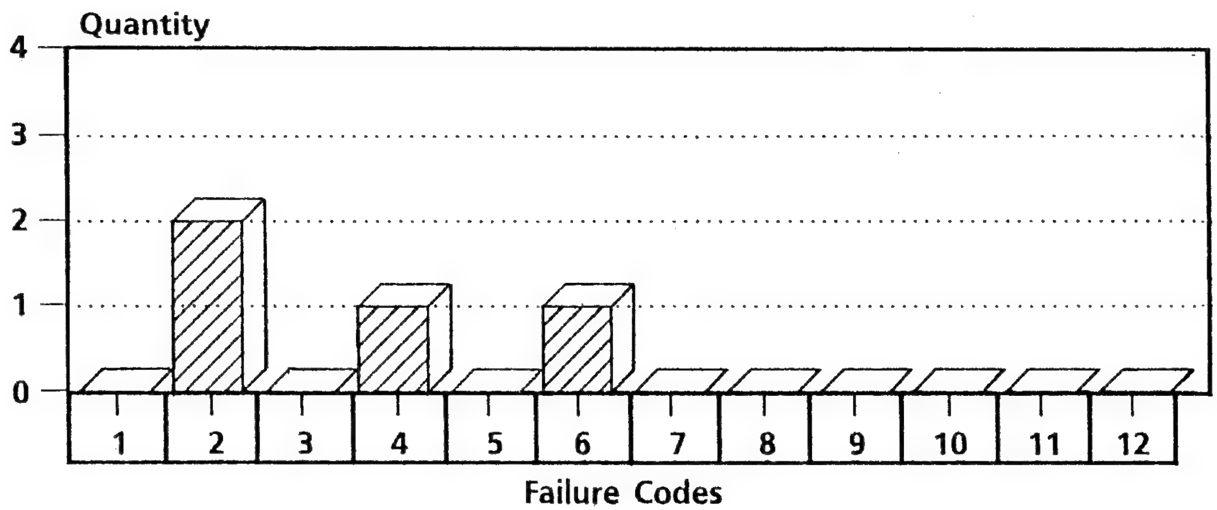
1 TWT Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(1980 Date Code)



Total Failures	0	2	0	1	0	1	0	0	0	0	0	0

2 TWT Tested

Total Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
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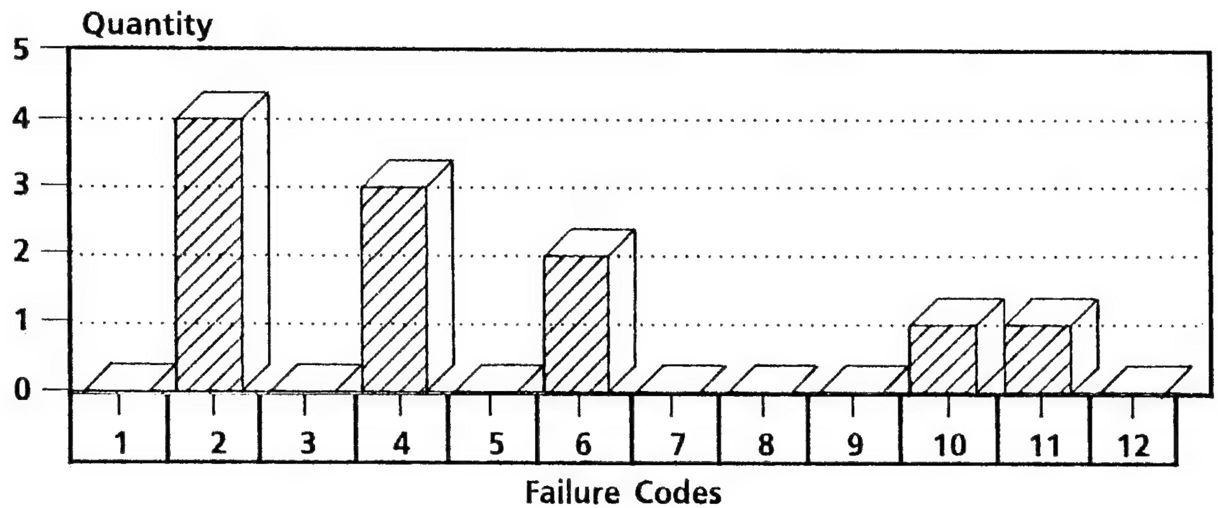
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(1981 Date Code)



Total Failures	0	4	0	3	0	2	0	0	0	1	1	0

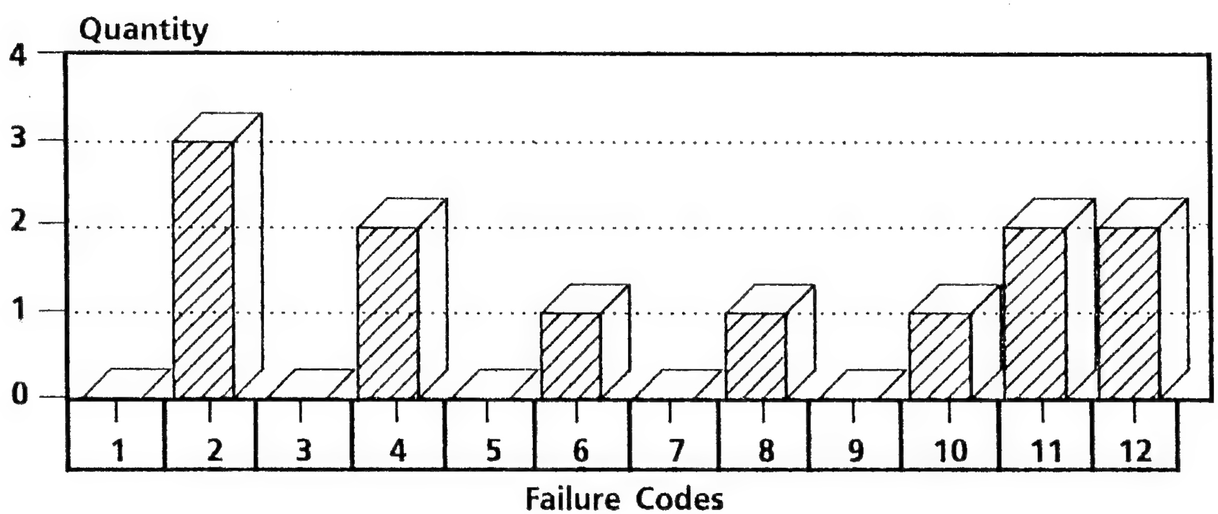
6 TWT Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(1982 Date Code)



Total Failures	0	3	0	2	0	1	0	1	0	1	2	2

6 TWT Tested

Total Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
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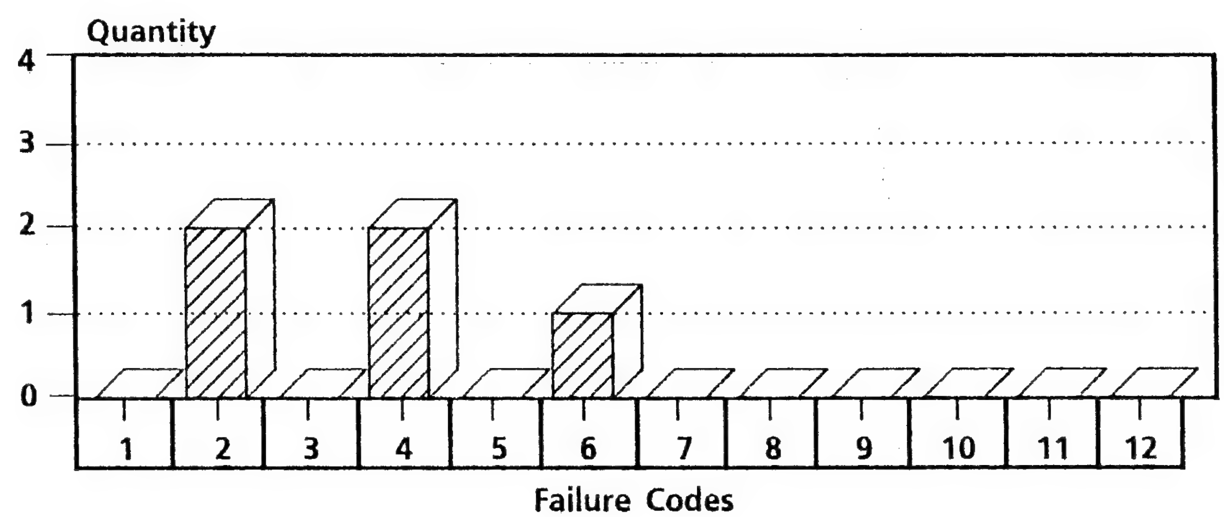
AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(1984 Date Code)



Total Failures	0	2	0	2	0	1	0	0	0	0	0	0

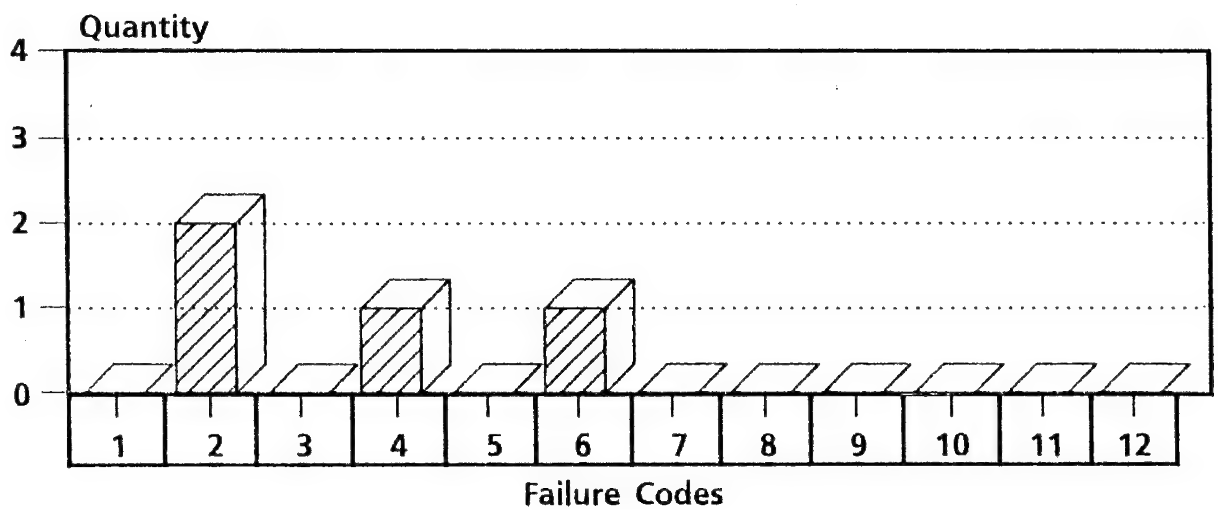
2 TWT Screened

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(1985 Date Code)



Total Failures	0	2	0	1	0	1	0	0	0	0	0	0

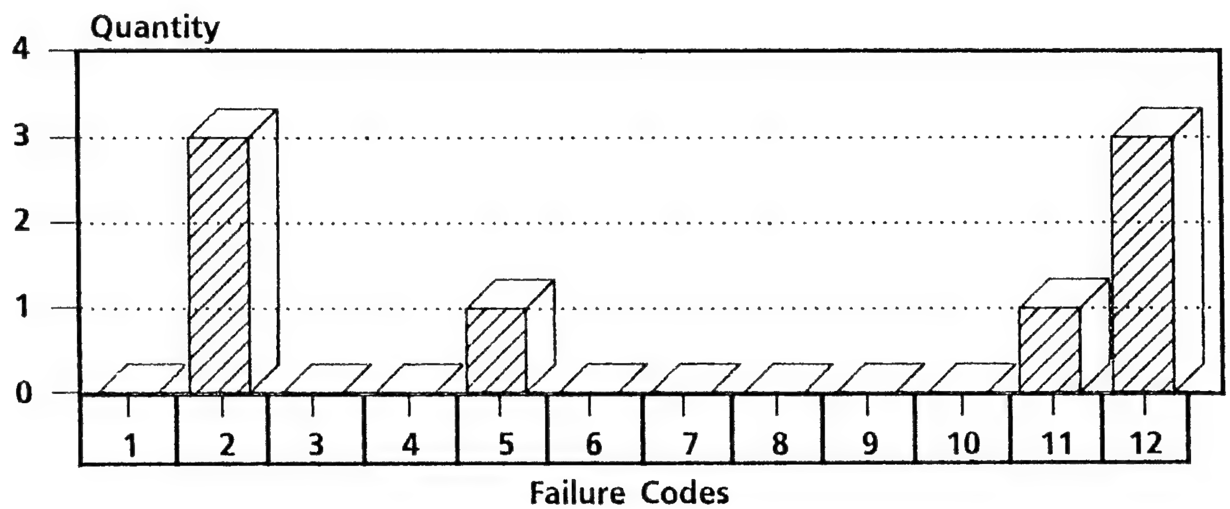
2 TWT Screened

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(1986 Date Code)



	1	2	3	4	5	6	7	8	9	10	11	12
Total Failures	0	3	0	0	1	0	0	0	0	0	1	3

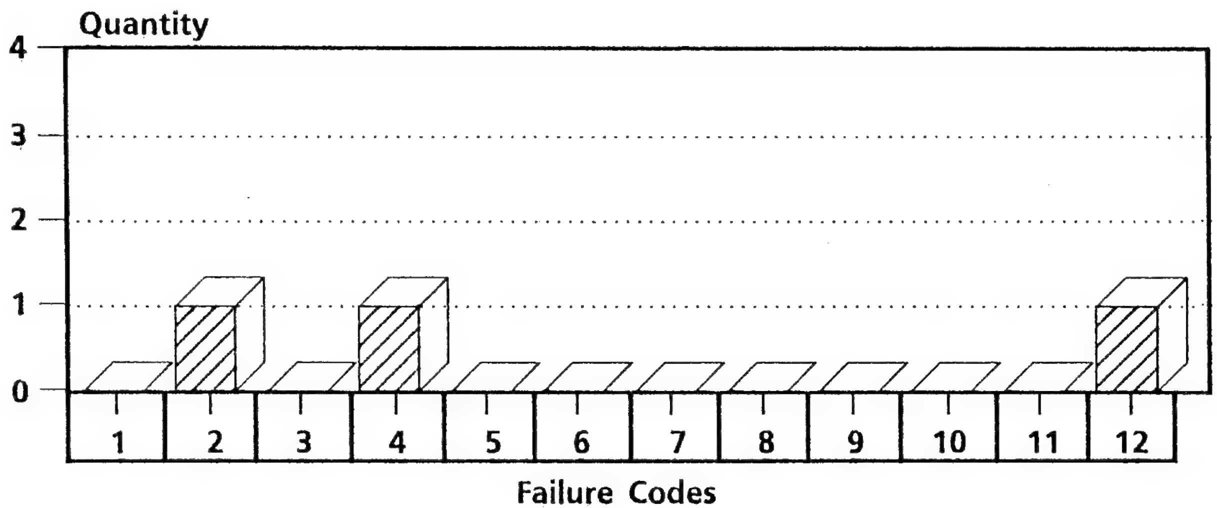
5 TWT Screened

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used)
(1987 Date Code)



Total Failures	0	1	0	1	0	0	0	0	0	0	0	1

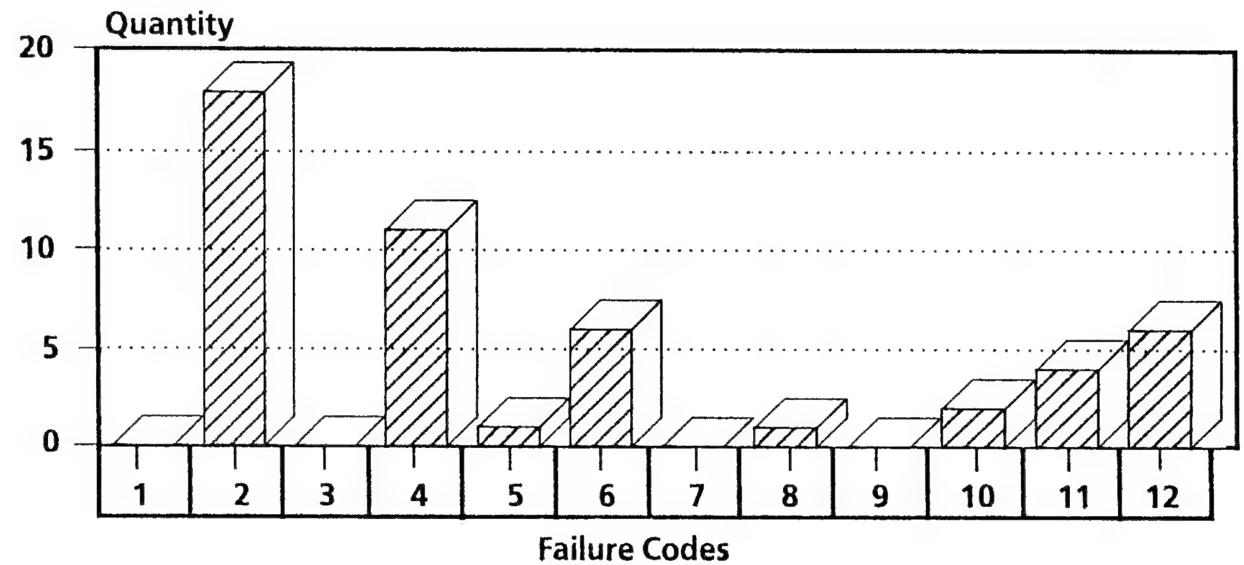
2 TWT Screened

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 3 Litton (Used) by Failure Codes



Total Failures	0	18	0	11	1	6	0	1	0	2	4	6

26 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
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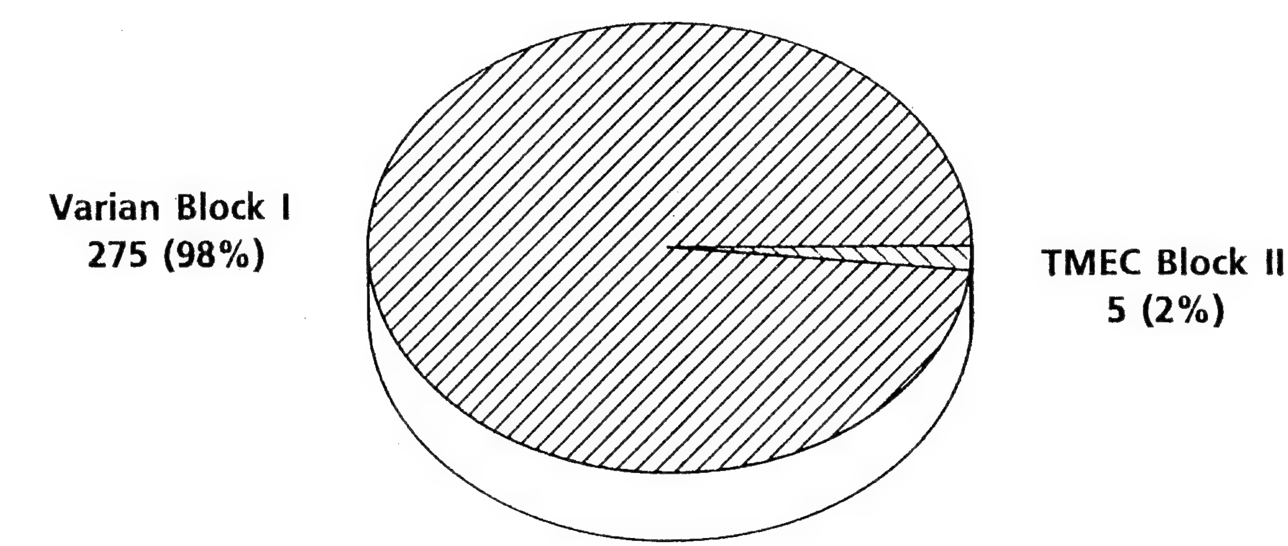
AN/ALQ-131 OUTPUT TWTs

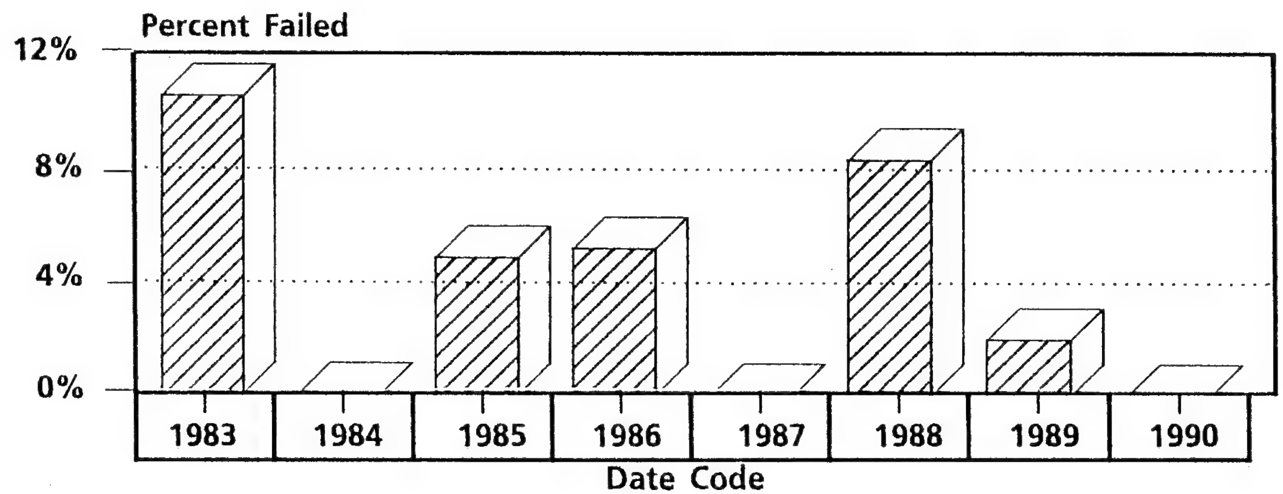
Screening Summary: Band 4 (New) Output TWTs by Vendor



280 TWTs Tested

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 (New)
(Failure Code 1)



	1983	1984	1985	1986	1987	1988	1989	1990
Percent Failed/Year	10.5%	0%	4.9%	5.2%	0%	8.3%	2%	0%

279 TWTs Screened

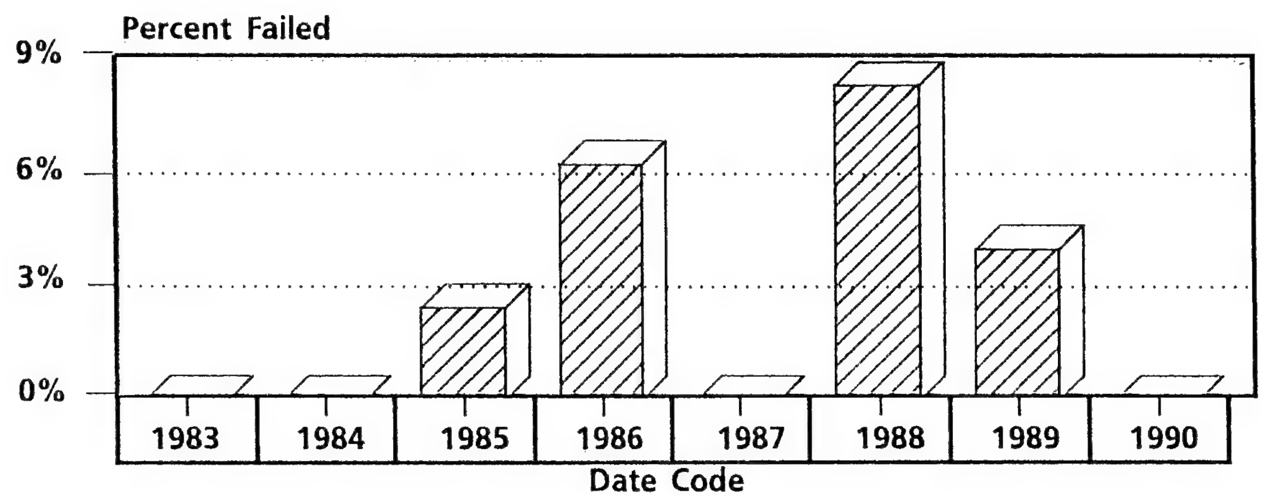
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 (New)
(Failure Code 2)



Percent Failed/Year	0%	0%	2.4%	6.3%	0%	8.3%	4%	0%

279 TWTs Screened

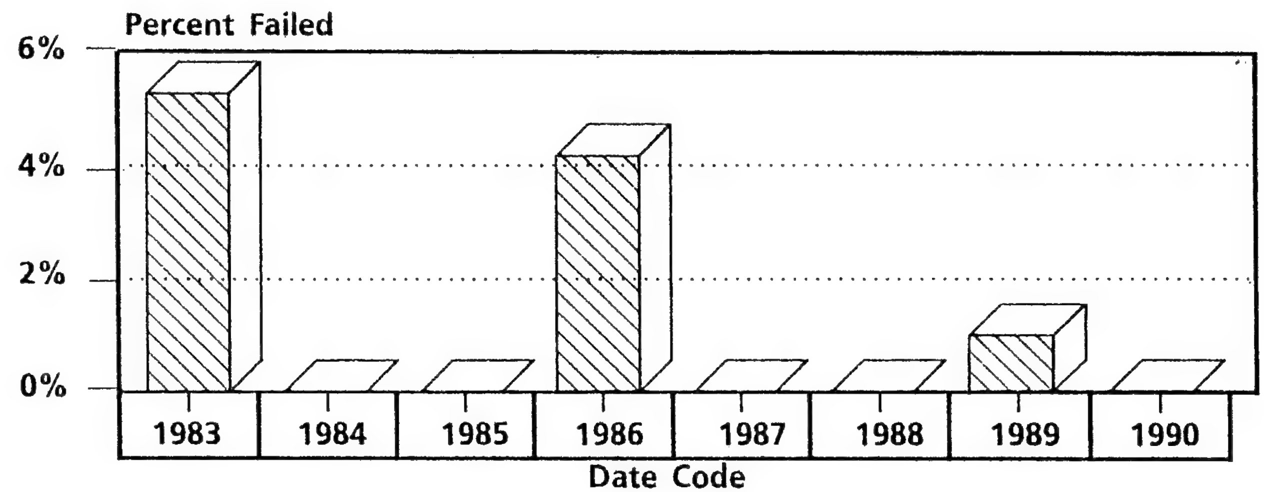
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 (New)
(Failure Code 3)



	1983	1984	1985	1986	1987	1988	1989	1990
Percent Failed/Year	5.3%	0%	0%	4.2%	0%	0%	1%	0%

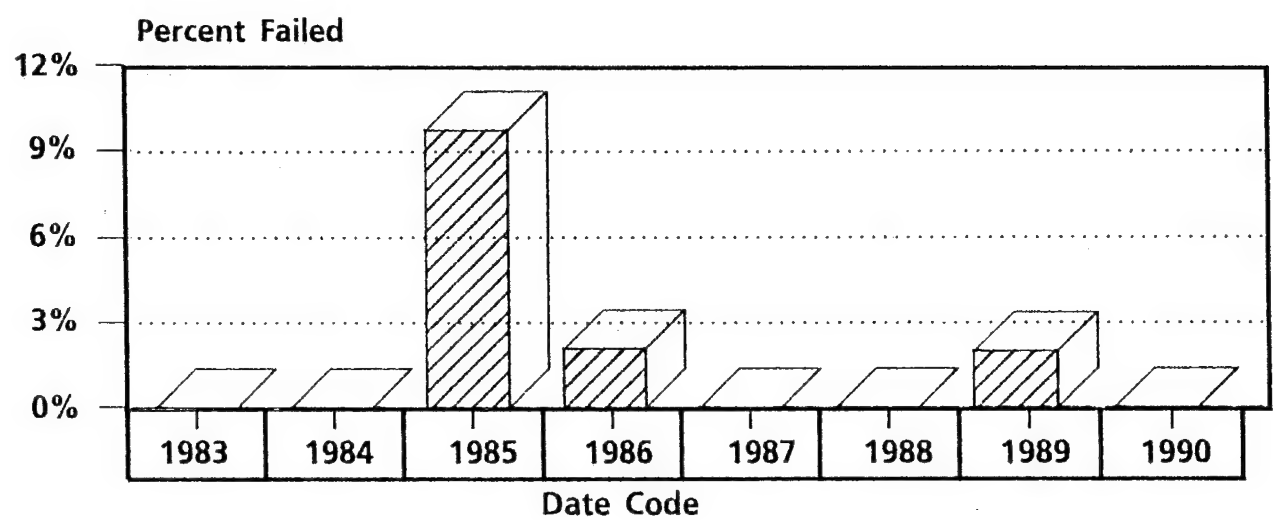
279 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 (New)
(Failure Code 5)



Percent Failed/Year	0%	0%	9.8%	2.1%	0%	0%	2%	0%

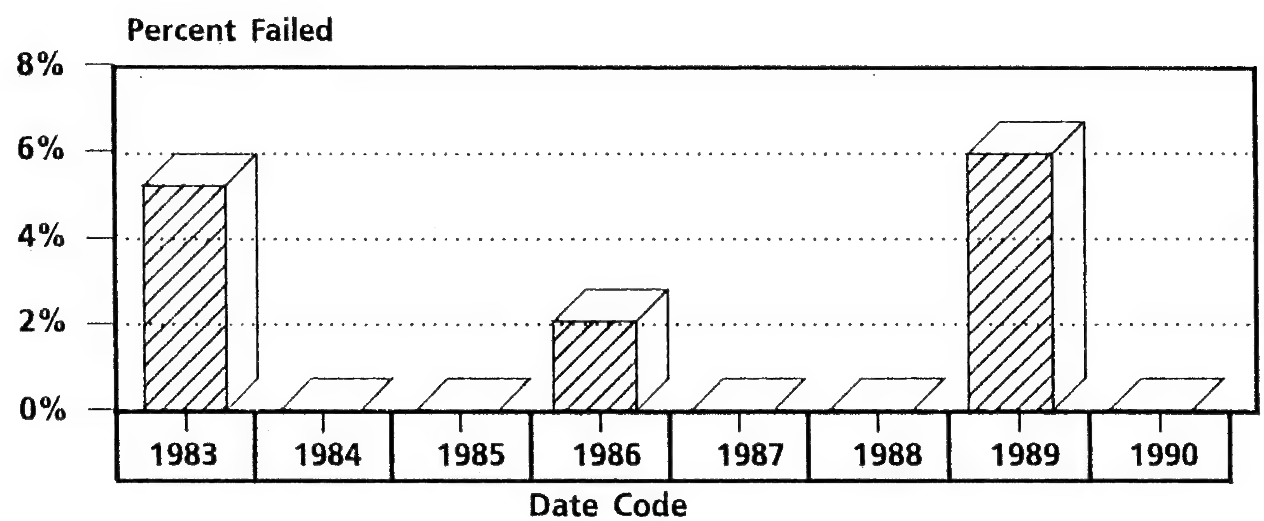
279 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 (New)
(Failure Code 6)



Percent Failed/Year	5.3%	0%	0%	2.1%	0%	0%	6%	0%

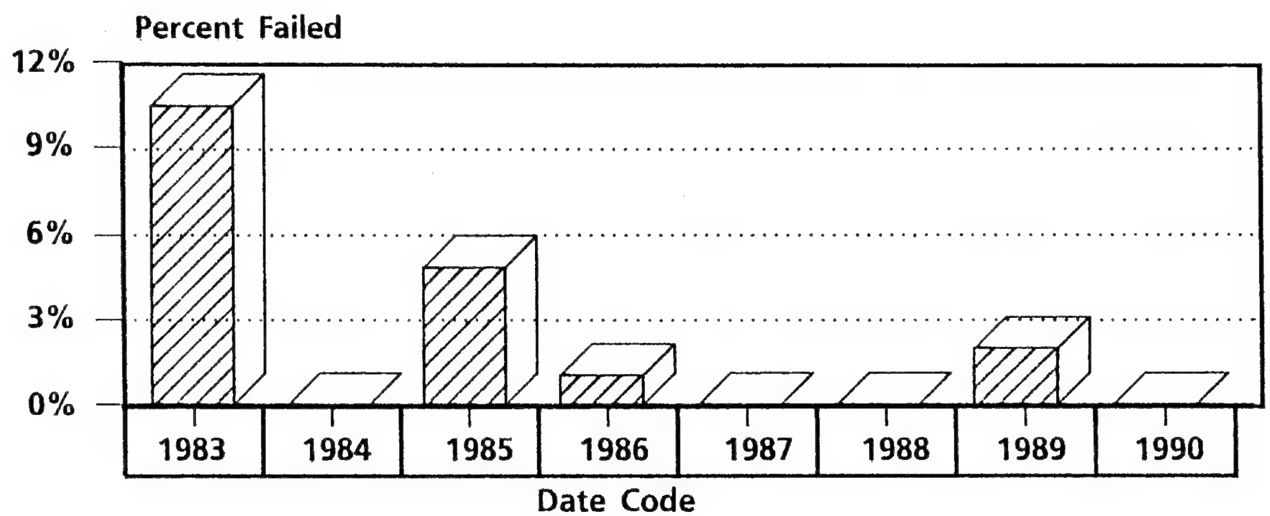
279 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 (New)
(Failure Code 7)



Percent Failed/Year	10.5%	0%	4.9%	1%	0%	0%	2%	0%

279 TWTs Screened

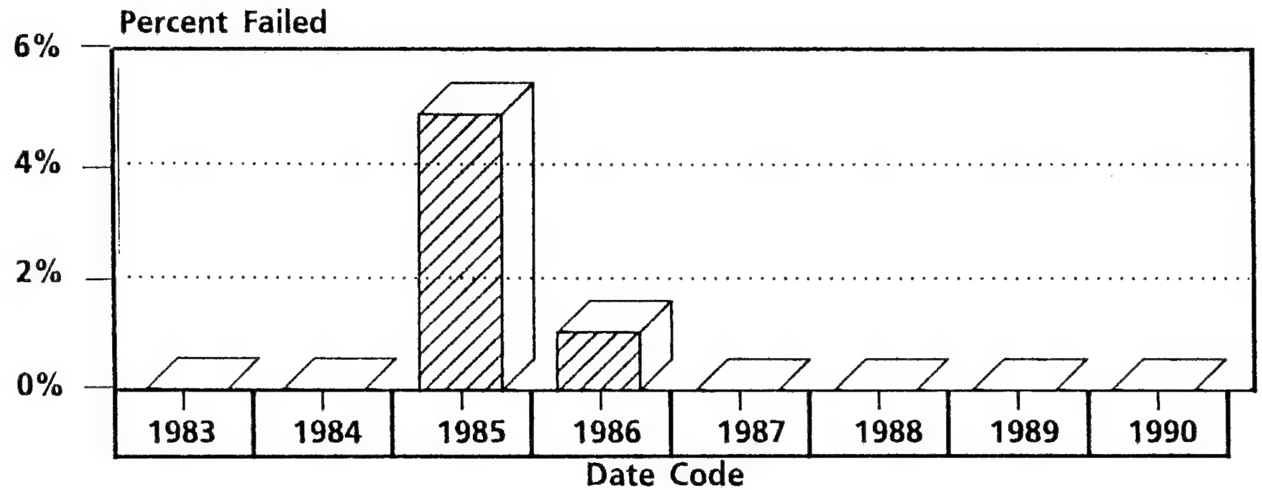
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 (New)
(Failure Code 8)



Percent Failed/Year	0%	0%	4.9%	1%	0%	0%	0%	0%

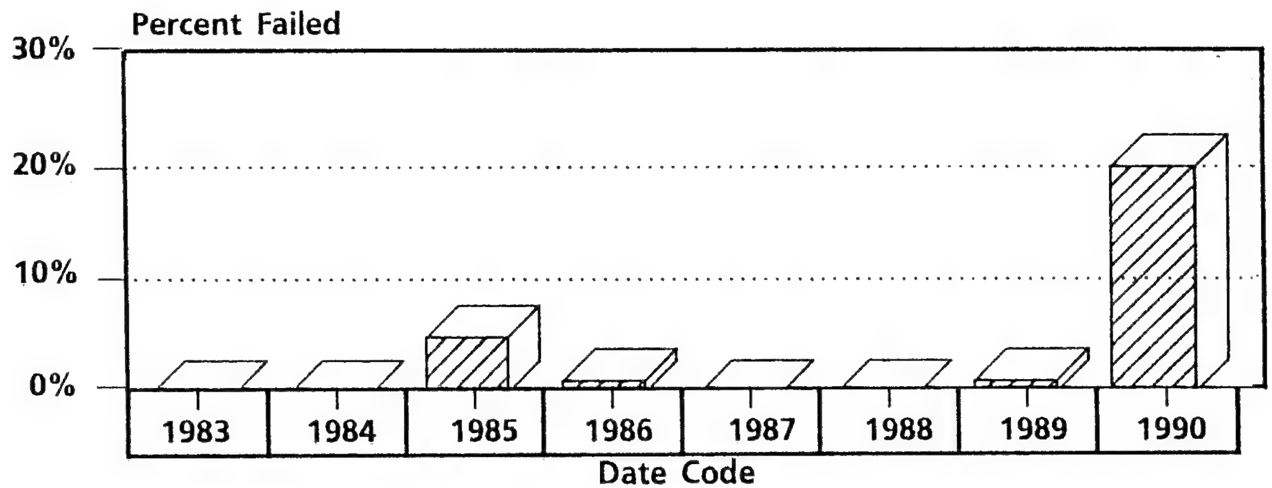
279 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 (New)
(Failure Code 9)



Percent Failed/Year	0%	0%	4.9%	1%	0%	0%	1%	20%

279 TWTs Screened

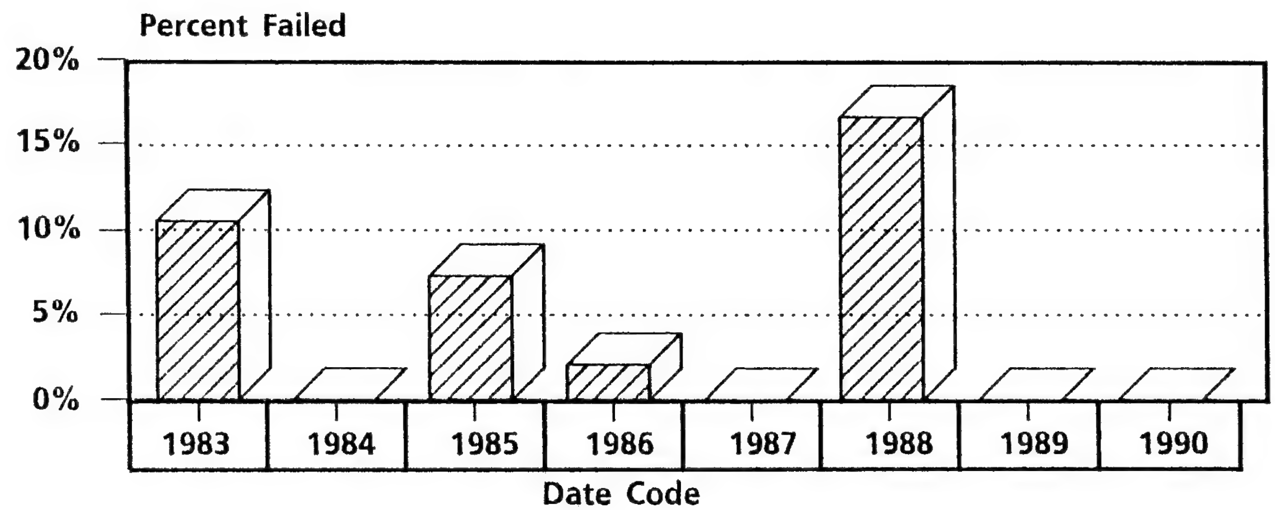
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 (New)
(Failure Code 10)



Percent Failed/Year	10.5%	0%	7.3%	2.1%	0%	16.7%	0%	0%

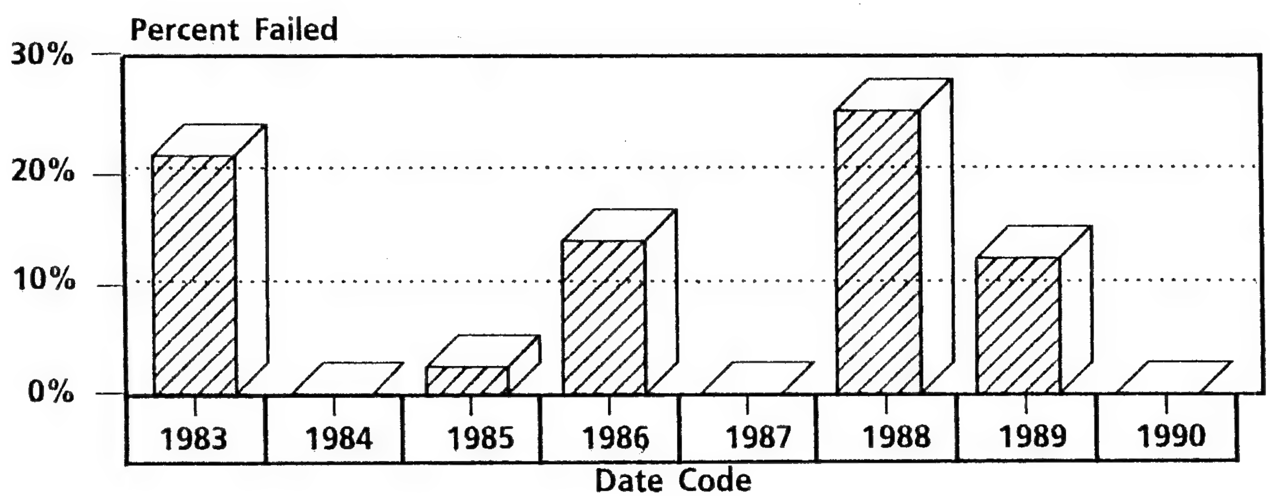
279 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 (New)
(Failure Code 12)



	1983	1984	1985	1986	1987	1988	1989	1990
Percent Failed/Year	21.1%	0%	2.4%	13.5%	0%	25%	12%	0%

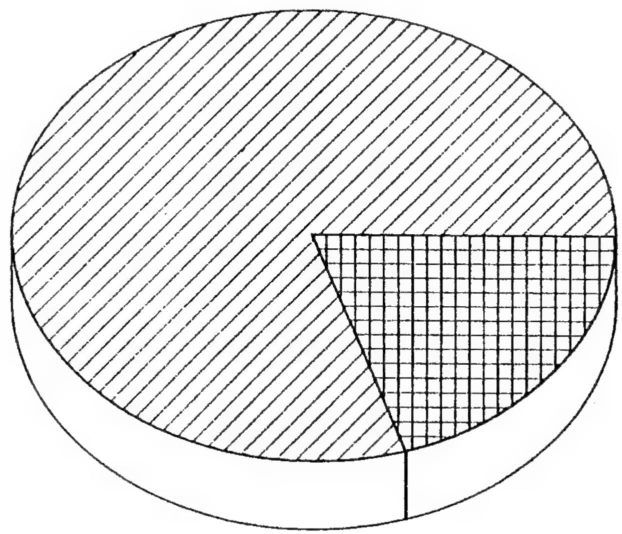
279 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

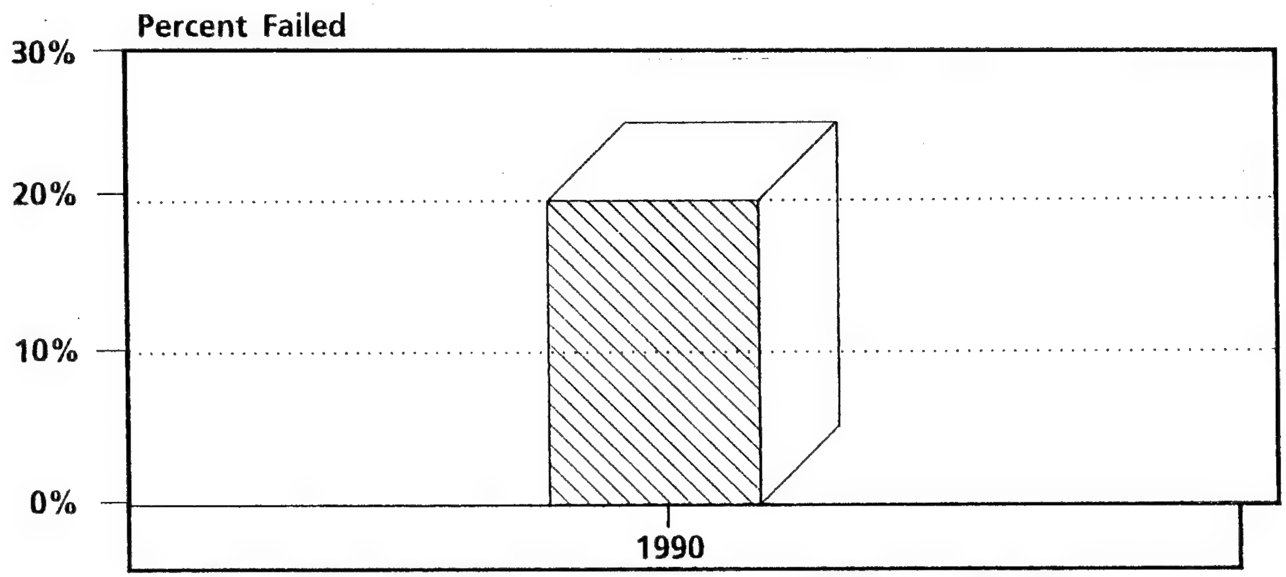
Screening Summary: Band 4 TMEC (New)



5 TWTs Tested
Block II

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 TMEC (New)
(Failure Code 9)



Percent Failed/Year	20%

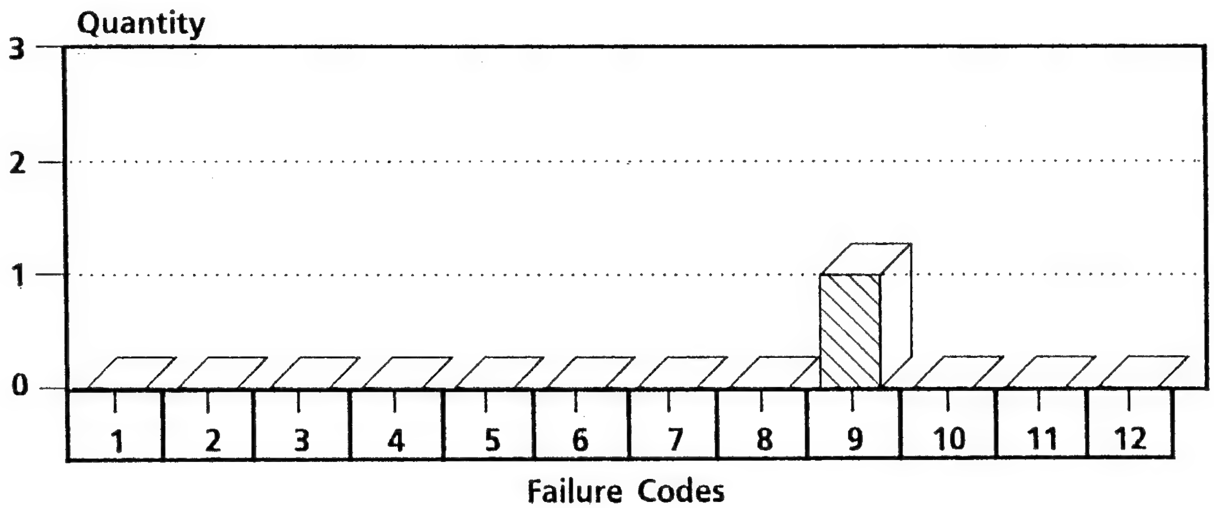
5 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 TMEC (New)
(1990 Date Code)



Total Failures	0	2	0	0	0	0	0	0	1	0	0	0

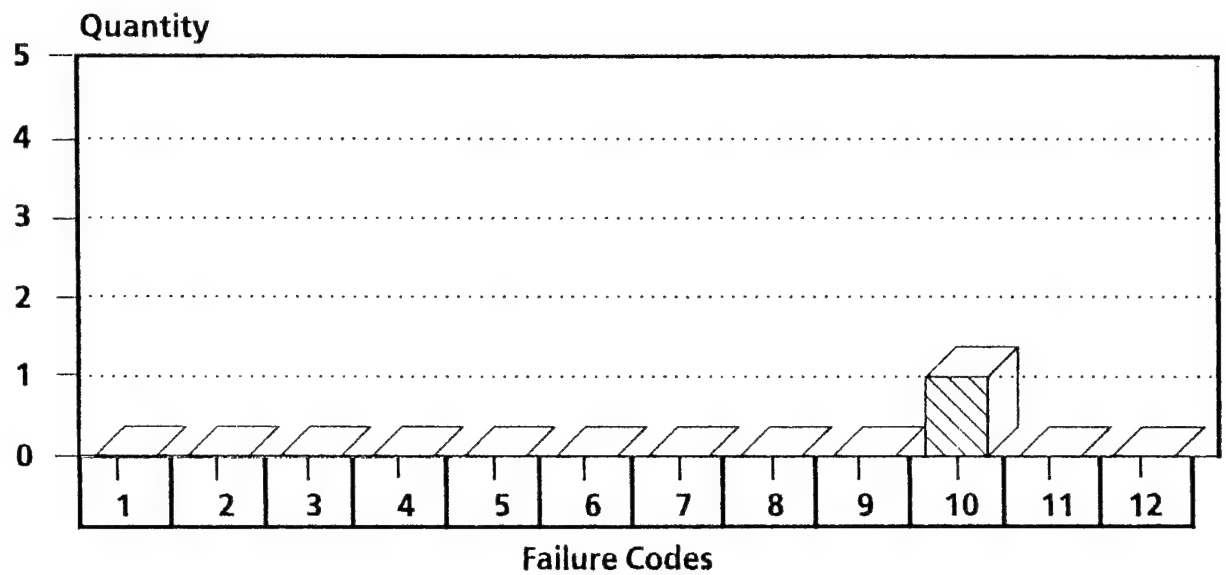
5 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 TMEC (New) by Failure Codes



Total Failures	0	0	0	0	0	0	0	0	0	1	0	0

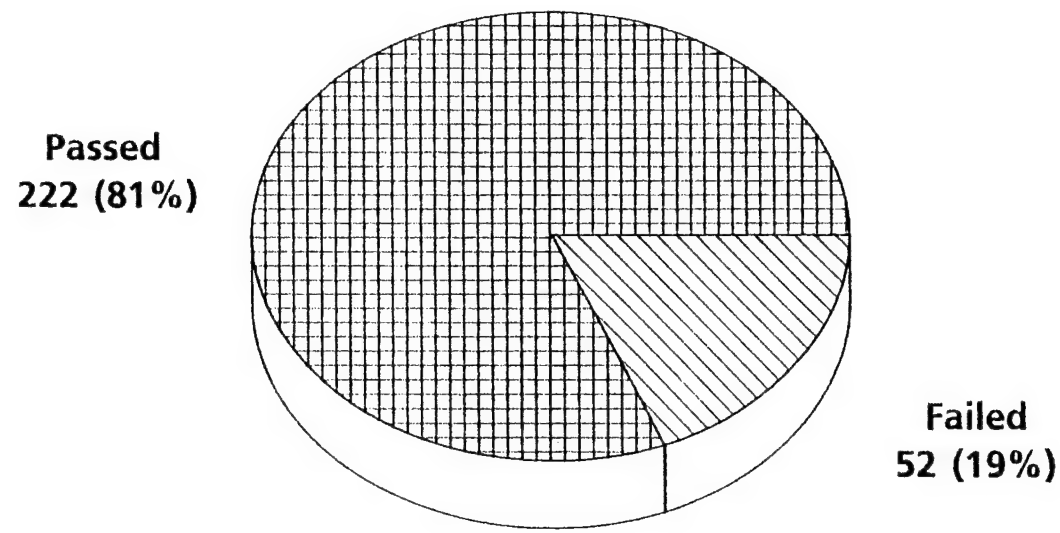
5 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

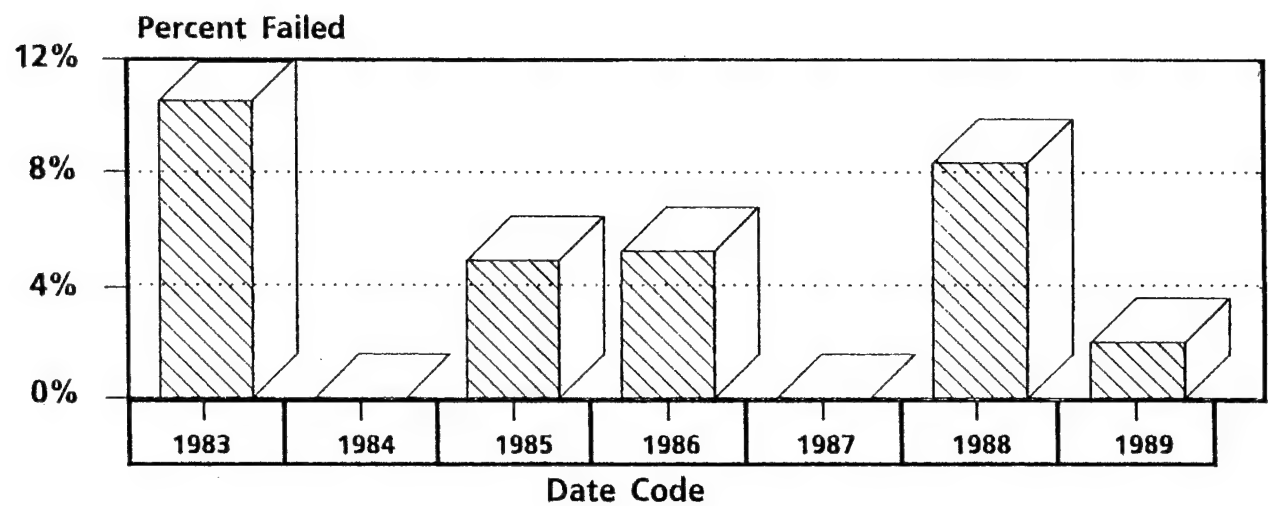
Screening Summary: Band 4 Varian (New)



274 TWTs Tested

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(Failure Code 1)



Percent Failed/Year	10.5%	0%	4.9%	5.2%	0%	8.3%	2%

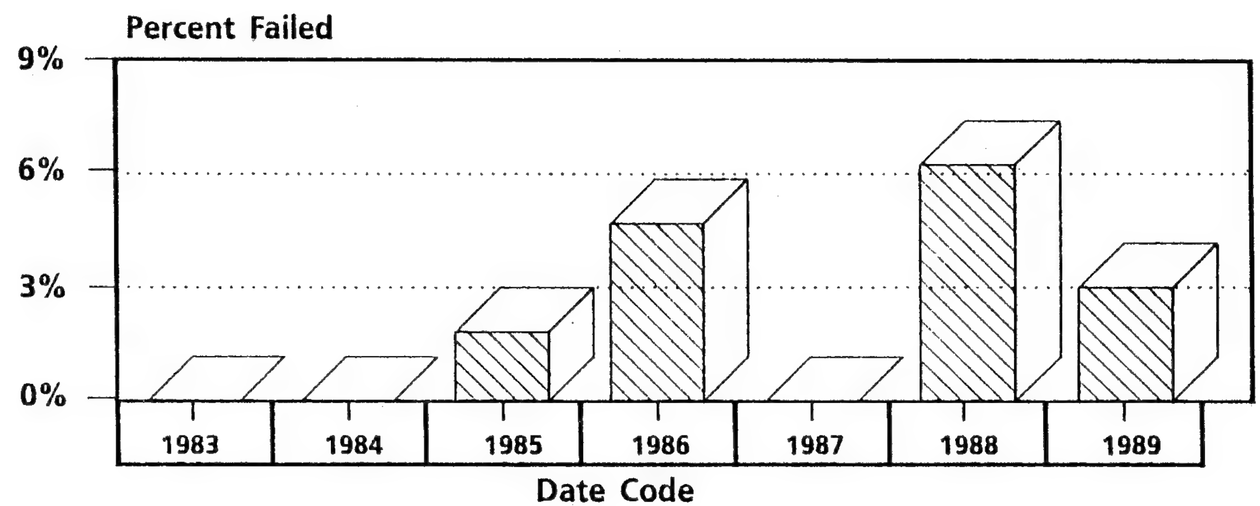
274 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(Failure Code 2)



Percent Failed/Year	0%	0%	2.4%	6.3%	0%	8.3%	4%

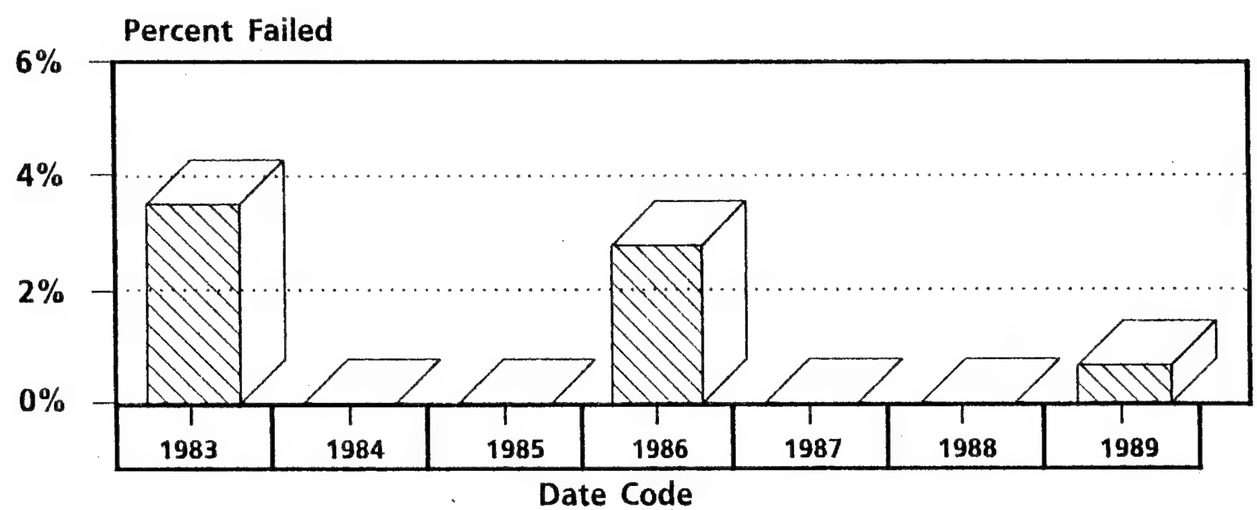
274 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(Failure Code 3)



Percent Failed/Year	5.3%	0%	0%	4.2%	0%	0%	1%

274 TWTs Screened

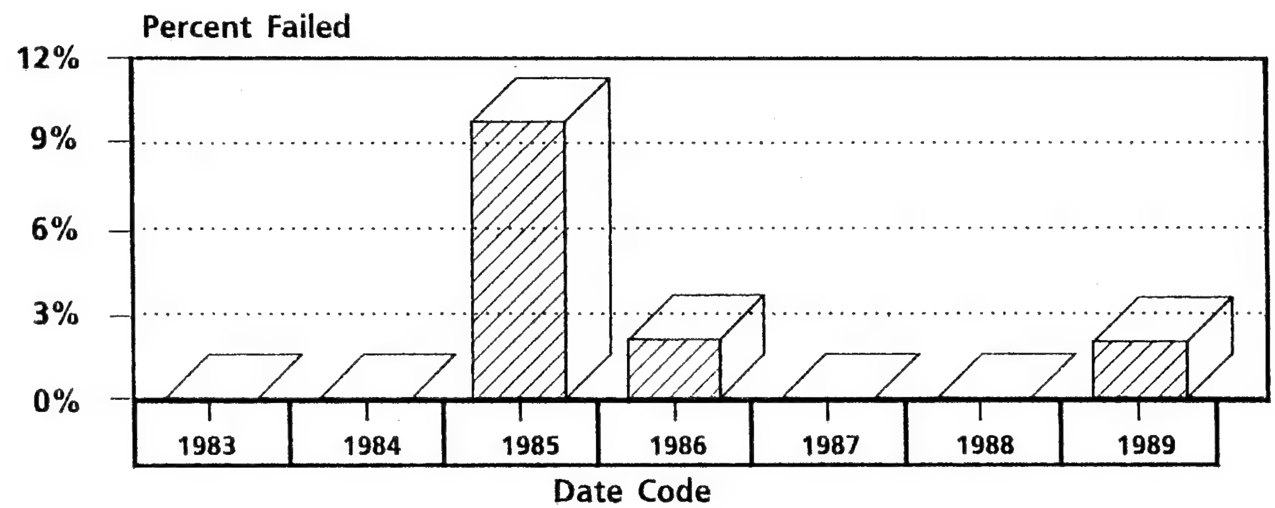
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(Failure Code 5)



Percent Failed/Year	0%	0%	9.8%	2.1%	0%	0%	2%

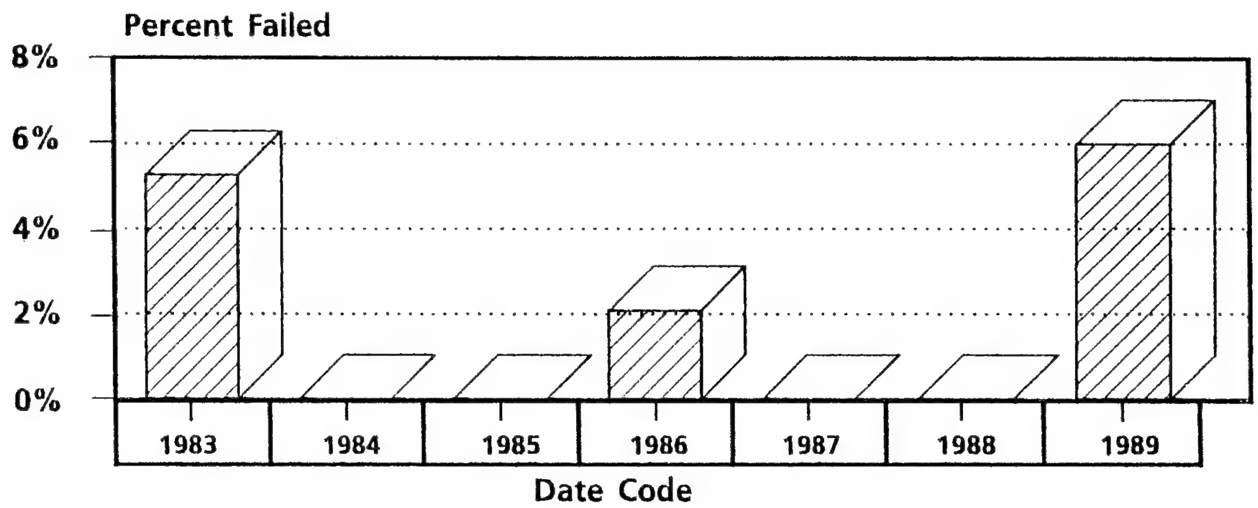
274 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(Failure Code 6)



Percent Failed/Year	5.3%	0%	0%	2.1%	0%	0%	6%

274 TWTs Screened

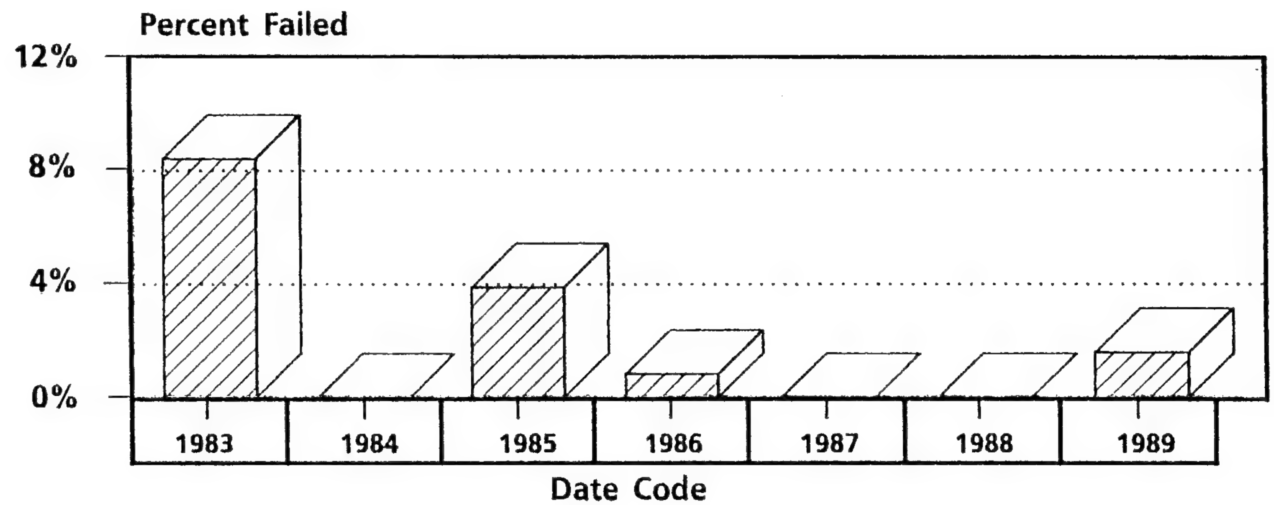
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(Failure Code 7)



Percent Failed/Year	10.5%	0%	4.9%	1%	0%	0%	2%

274 TWTs Screened

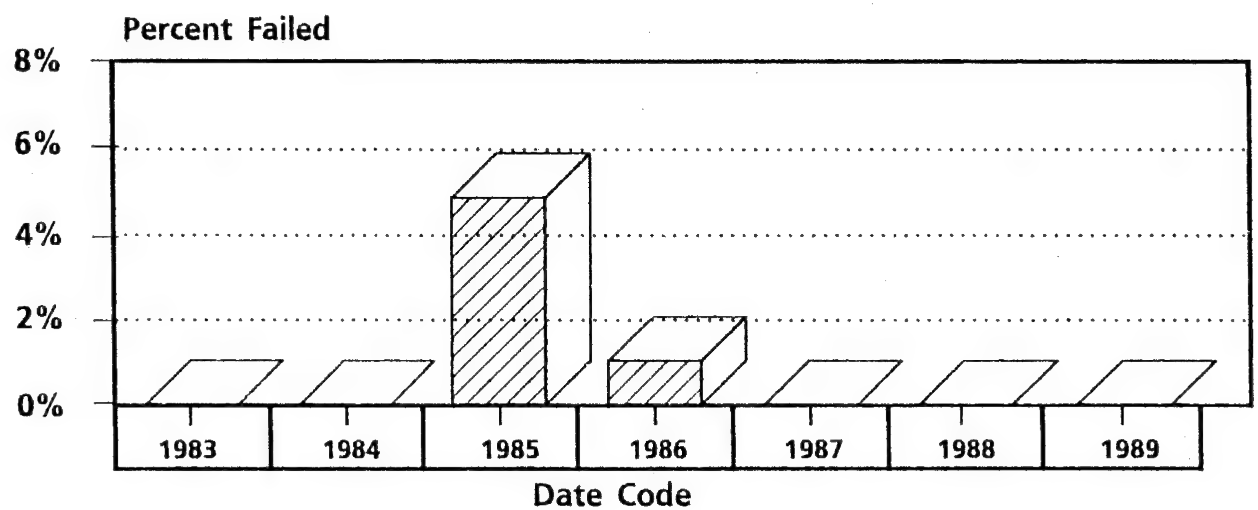
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(Failure Code 8)



Percent Failed/Year	0%	0%	4.9%	1%	0%	0%	0%

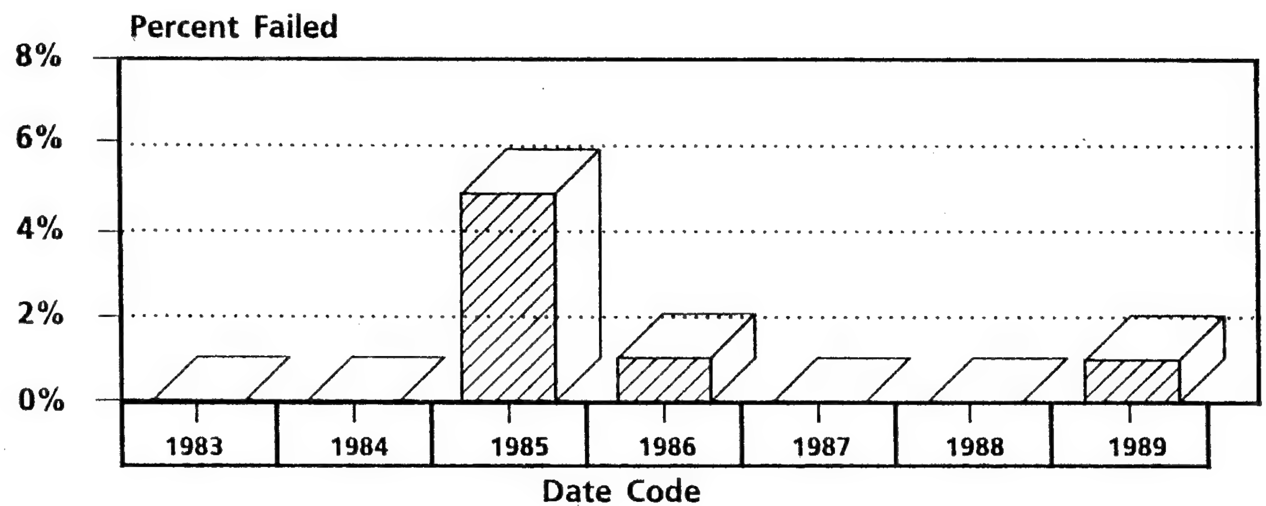
274 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(Failure Code 9)



Percent Failed/Year	0%	0%	4.9%	1%	0%	0%	1%

274 TWTs Screened

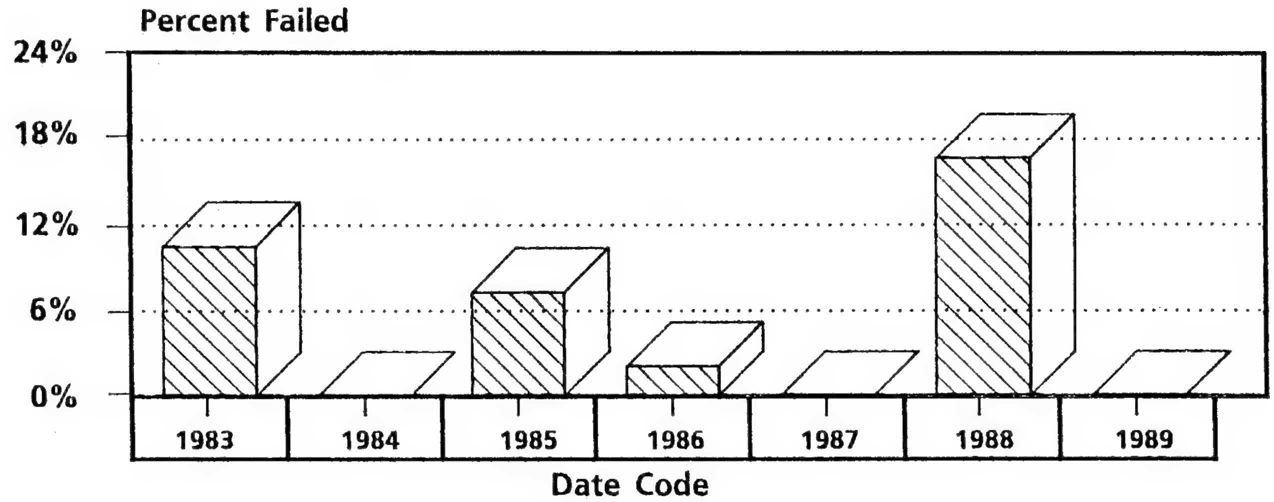
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(Failure Code 10)



Percent Failed/Year	10.5%	0%	7.3%	2.1%	0%	16.7%	0%

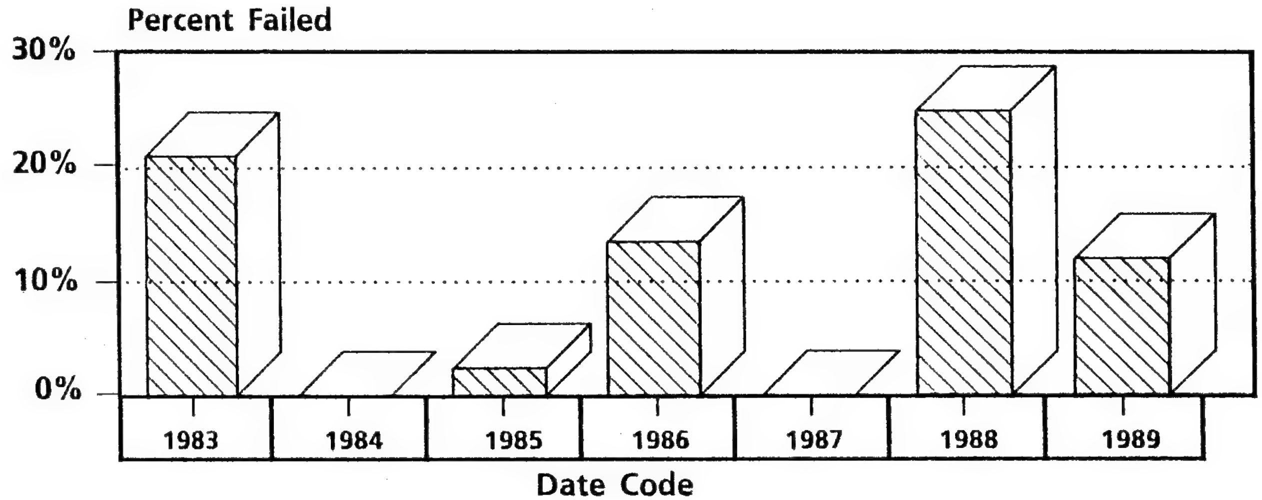
274 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(Failure Code 12)



Percent Failed/Year	21.1%	0%	2.4%	13.5%	0%	25%	12%

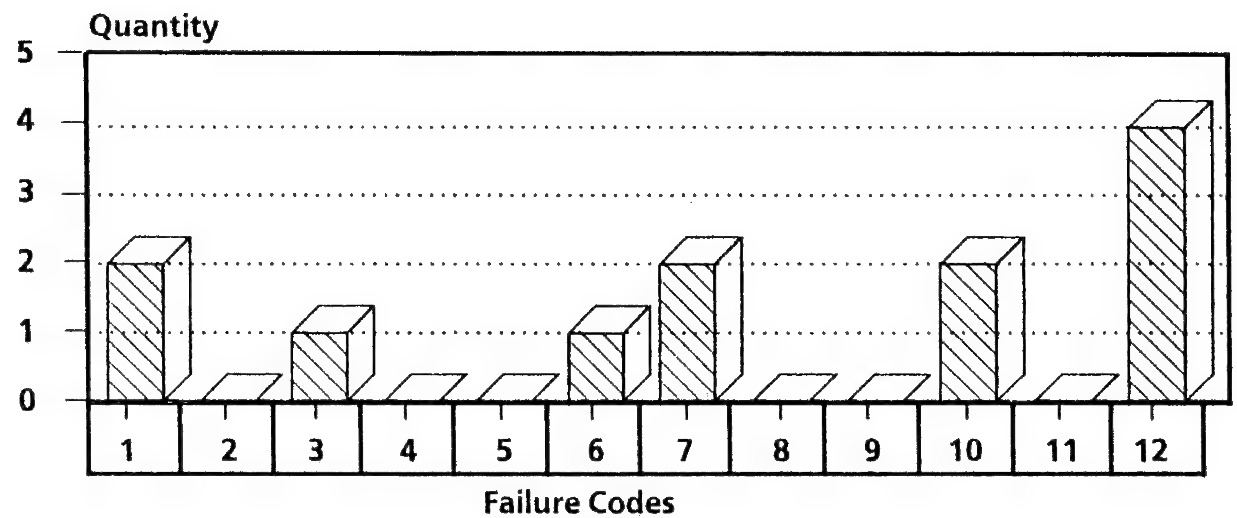
274 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(1983 Date Code)

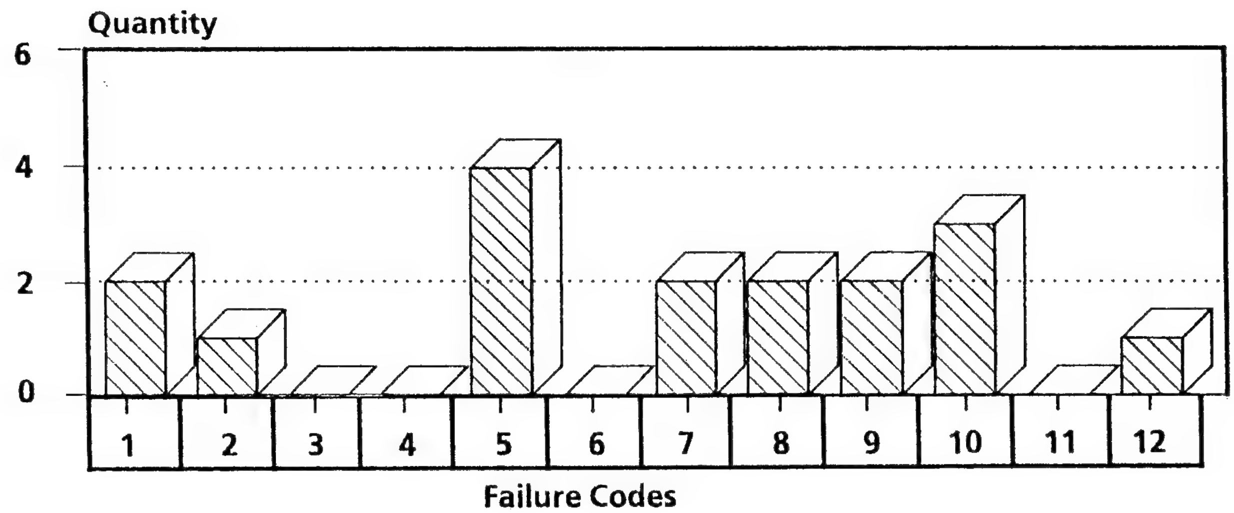


	1	2	3	4	5	6	7	8	9	10	11	12
Total Failures	2	0	1	0	0	1	2	0	0	2	0	4

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(1985 Date Code)



Total Failures	2	1	0	0	4	0	2	2	2	3	0	1

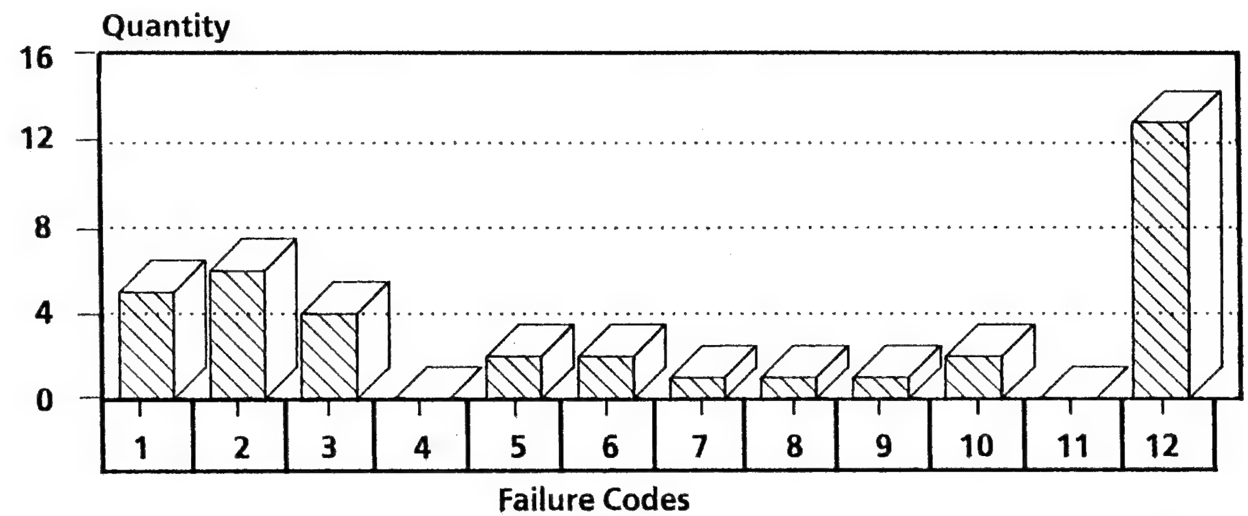
41 TWTs Screened

▨ Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(1986 Date Code)



Total Failures	5	6	4	0	2	2	1	1	1	2	0	13

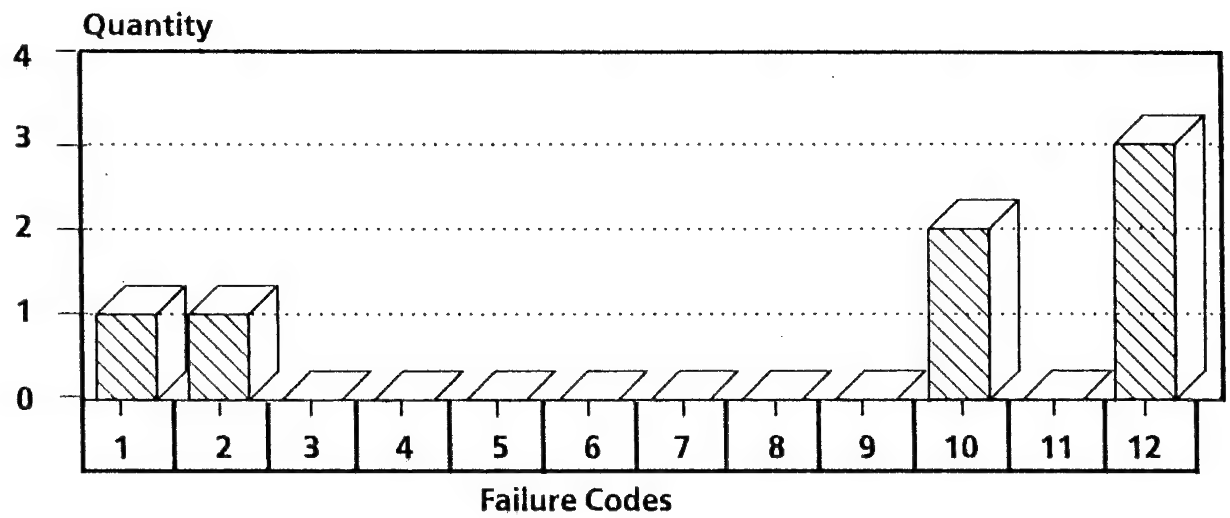
96 TWTs Screened

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(1988 Failure Code)



Total Failures	1	1	0	0	0	0	0	0	0	2	0	3

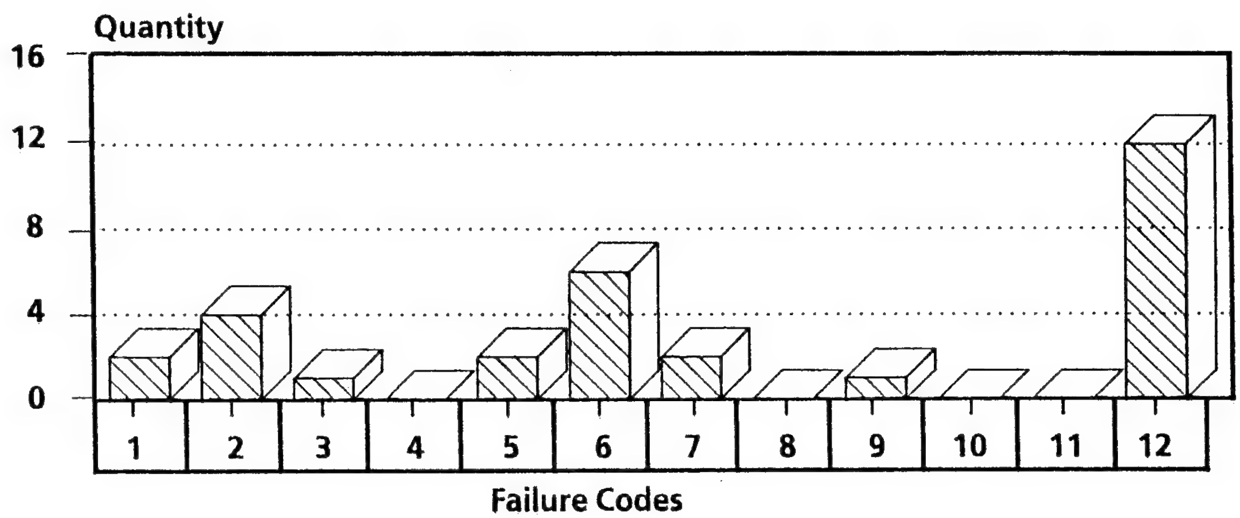
12 TWTs Screened

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New)
(1989 Date Code)



Total Failures	2	4	1	0	2	6	2	0	1	0	0	12

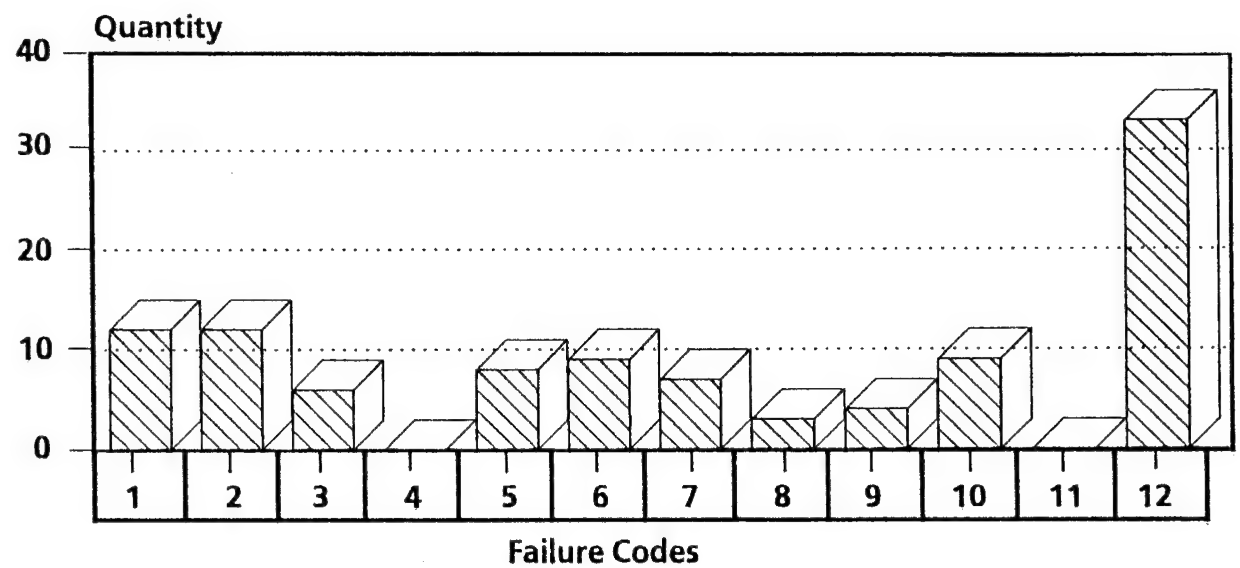
100 TWTs Screened

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 4 Varian (New) by Failure Codes



Total Failures	12	12	6	0	8	9	7	3	4	9	0	33

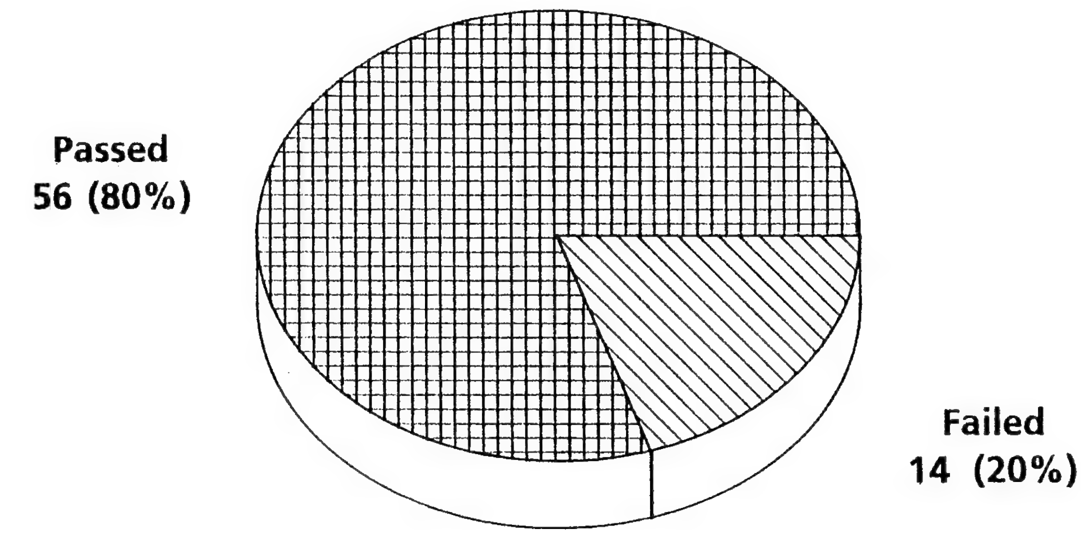
274 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

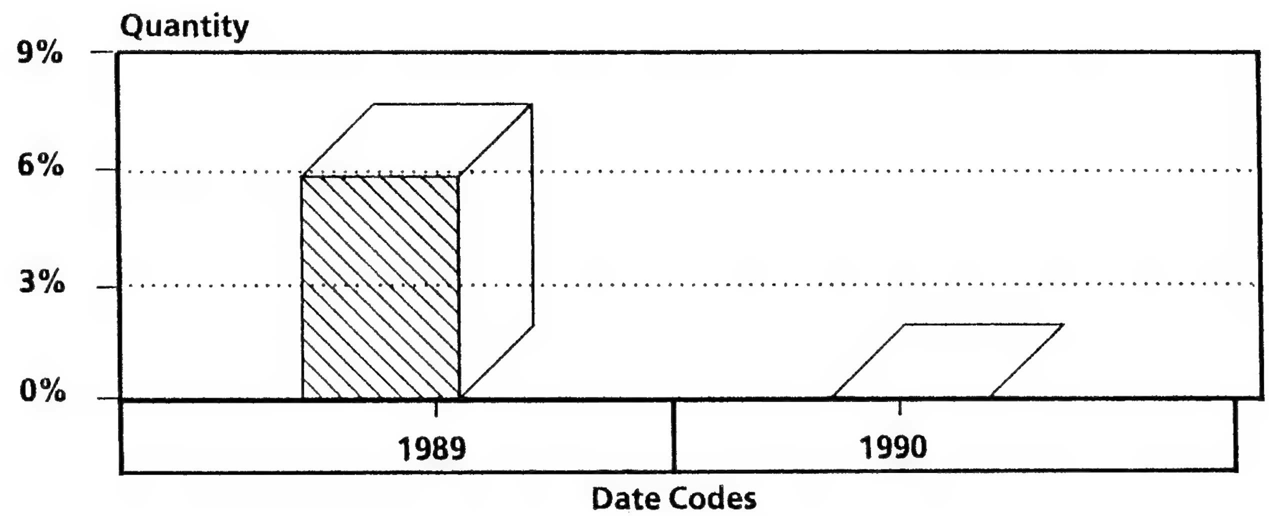
Screening Summary: Band 5 Varian (New)



70 TWTs Tested

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 5 Varian (New)
(Failure Code 2)



Percent Failed/Year	5.9%	0%

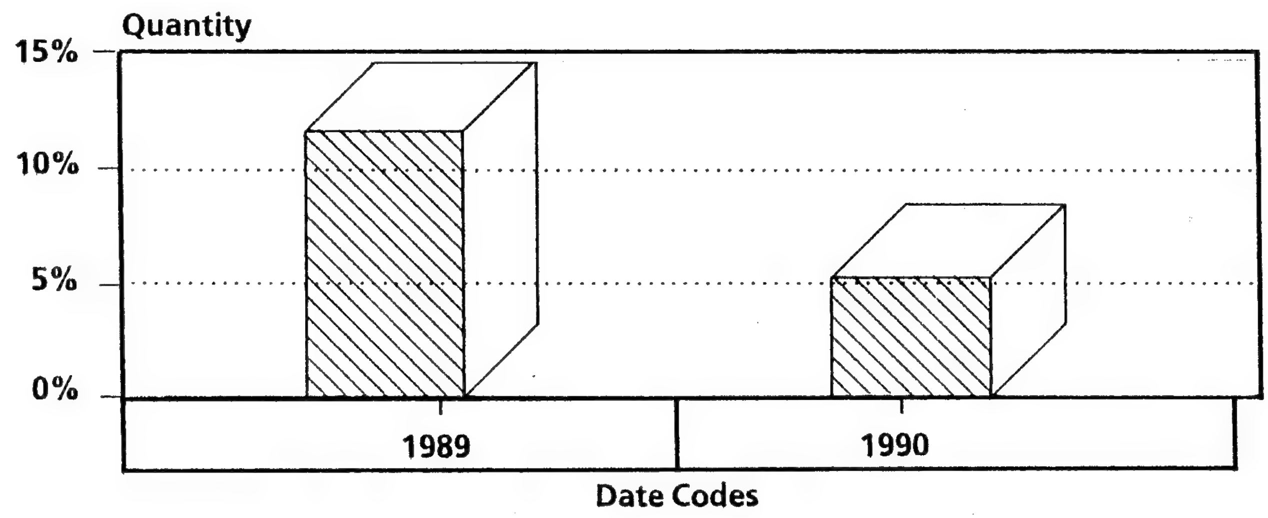
70 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 5 Varian (New)
(Failure Code 4)



Percent Failed/Year	11.8%	5.3%

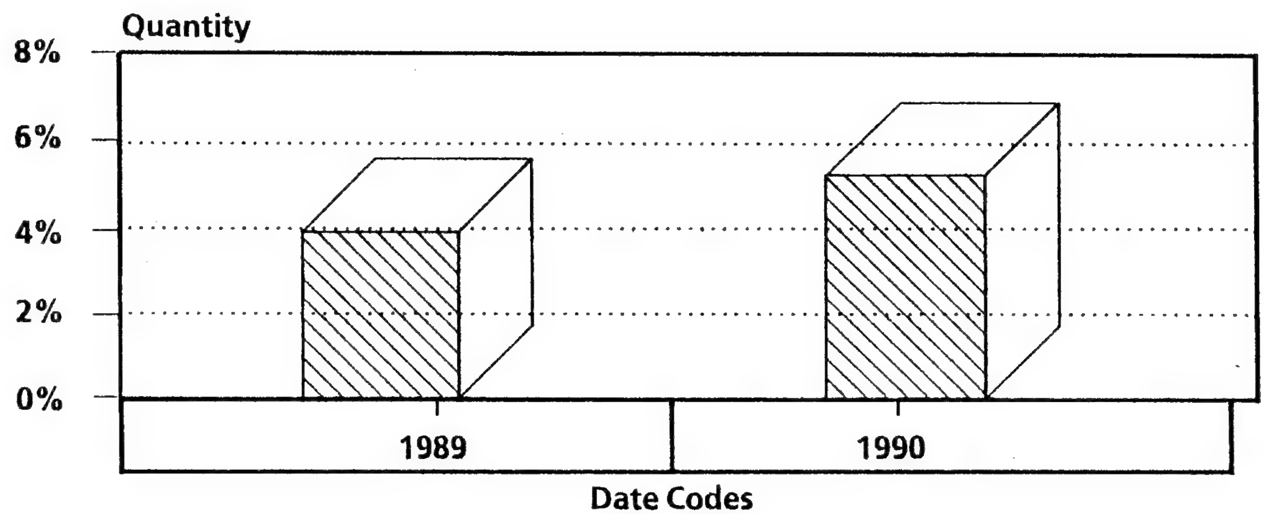
70 TWTs Screened

Percent Failed/Year

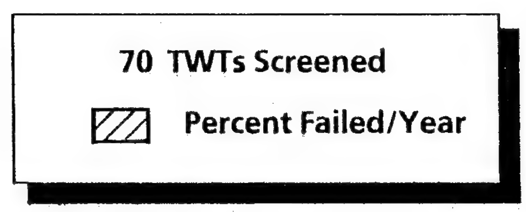
* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 5 Varian (New)
(Failure Code 5)



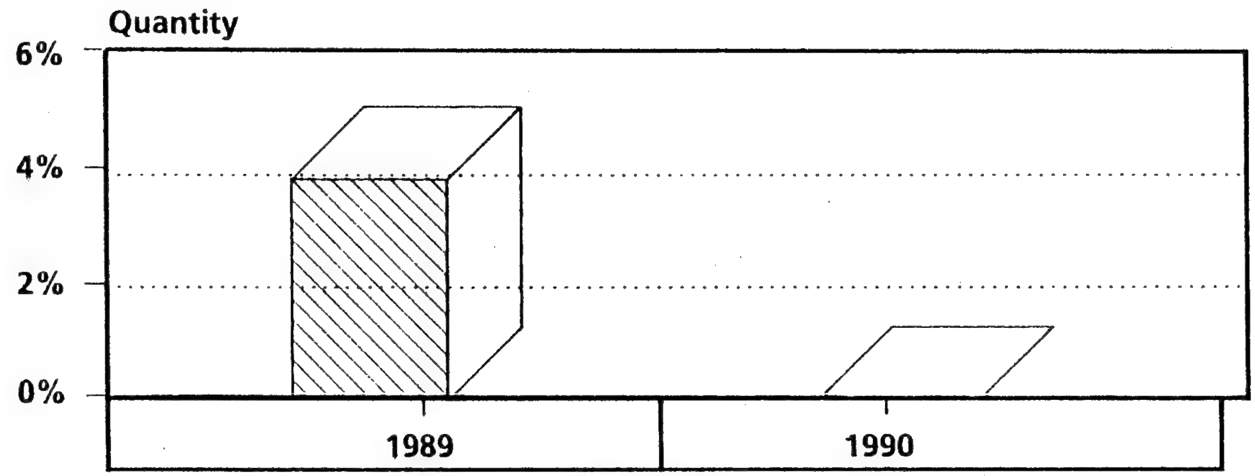
Percent Failed/Year	3.9%	5.3%



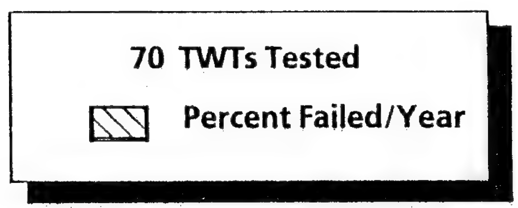
* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 5 Varian (New)
(Failure Code 9)



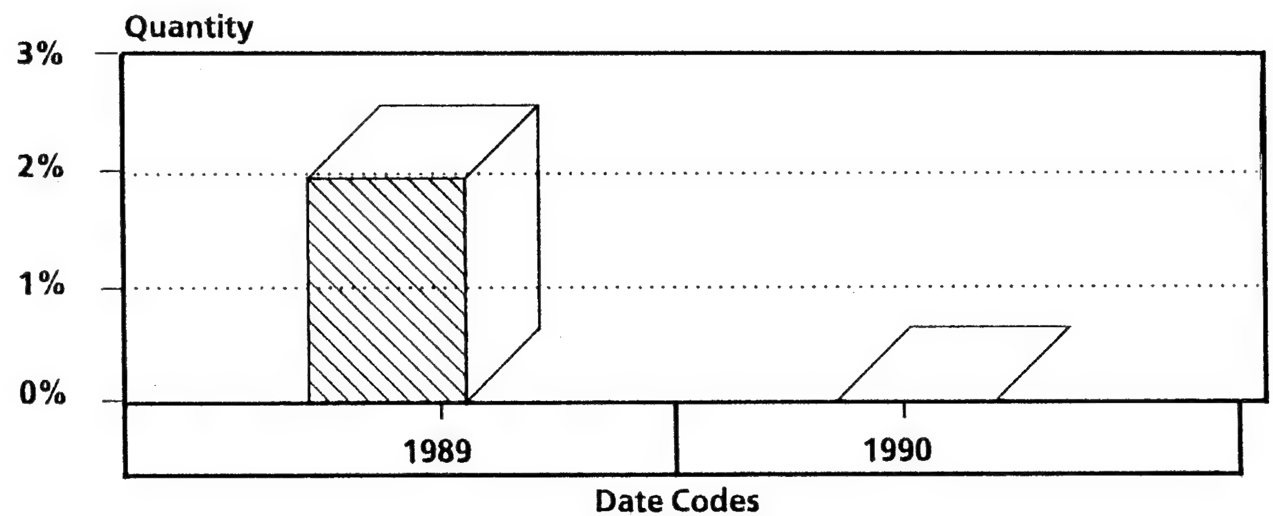
Percent Failed/Year	3.9%	0%



* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 5 Varian (New)
(Failure Code 10)



Percent Failed/Year	2%	0%

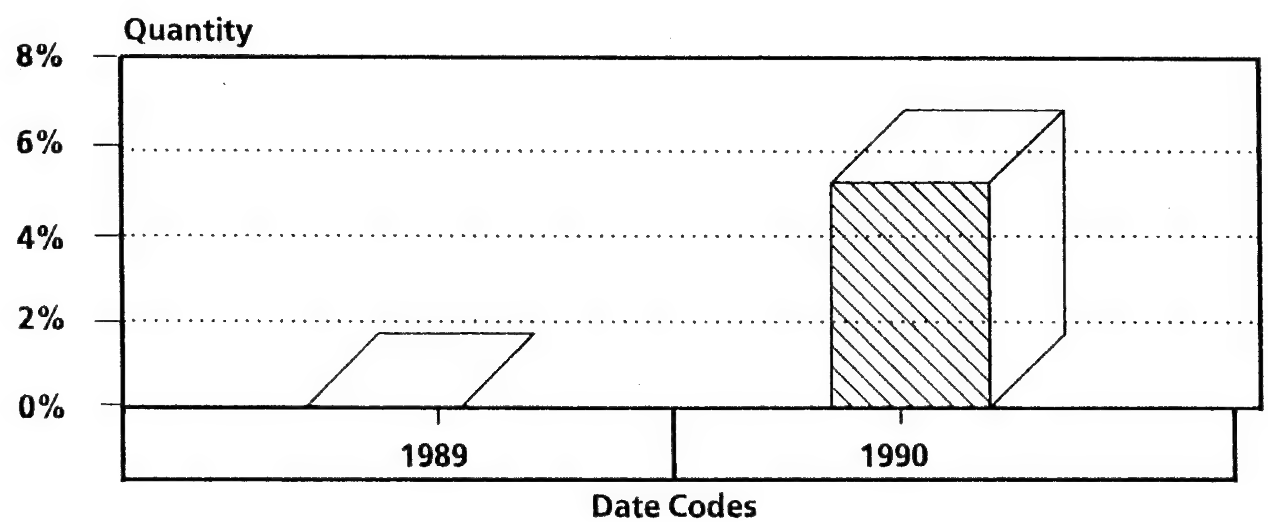
70 TWTs Tested

Percent Failed/Year

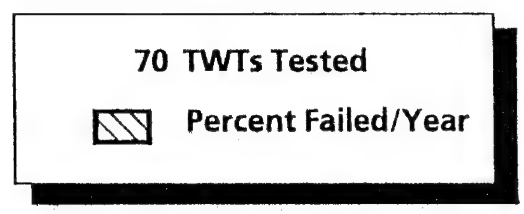
* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 5 Varian (New)
(Failure Code 12)



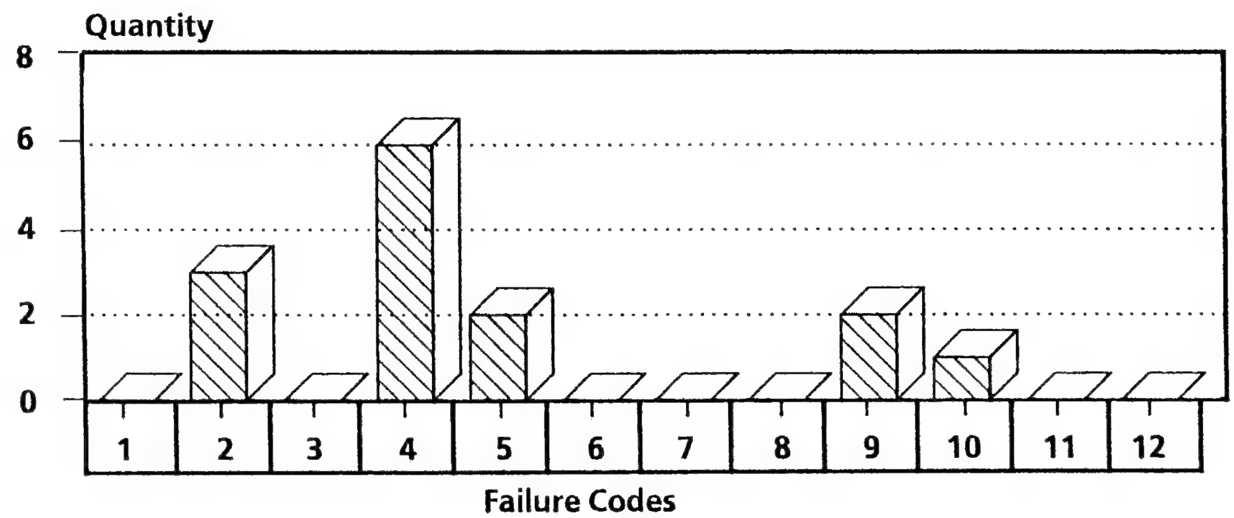
Percent Failed/Year	0%	5.3%



* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 5 Varian (New)
(1989 Date Code)



Total Failures	0	3	0	6	2	0	0	0	2	1	0	0

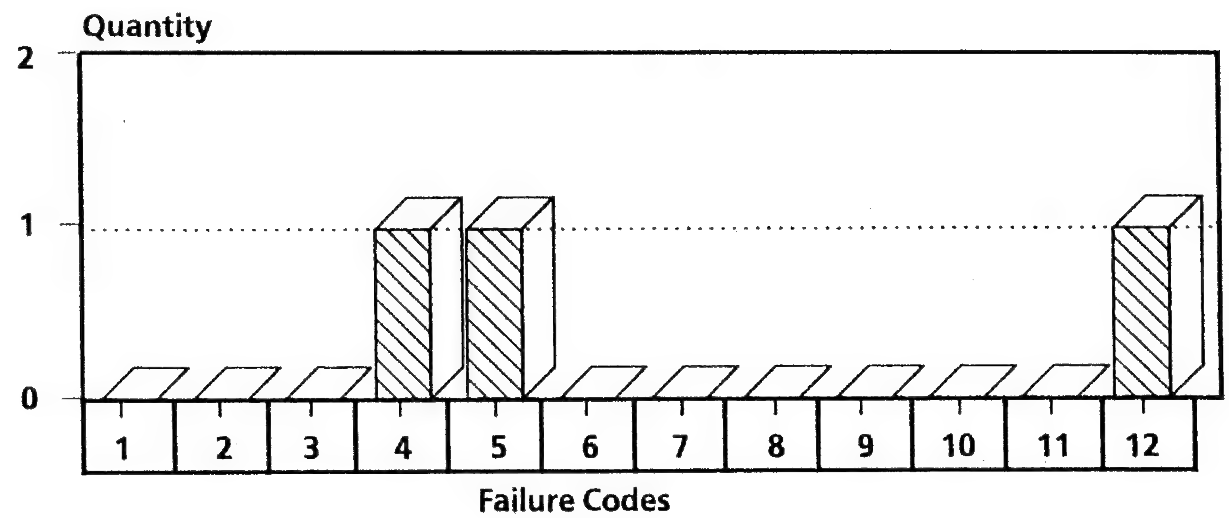
51 TWTs Screened

Total Failures

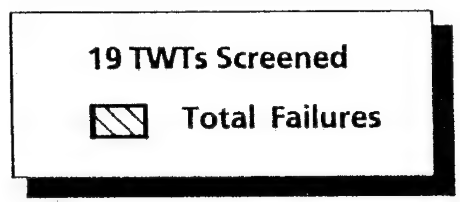
* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 5 Varian (New)
(1990 Date Code)



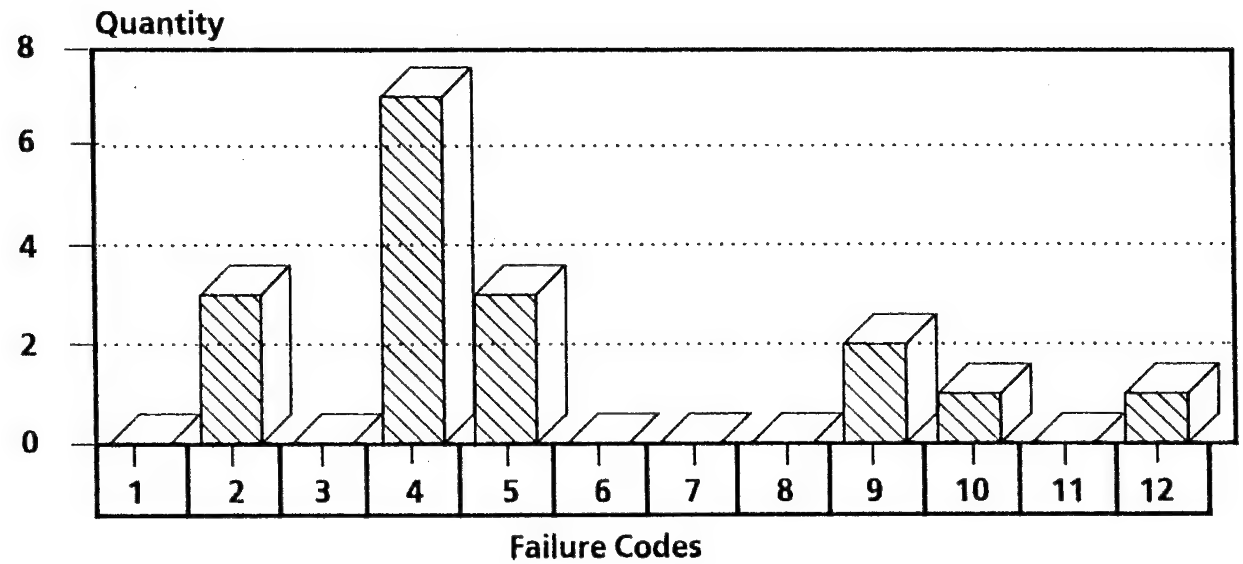
Total Failures	0	0	0	1	1	0	0	0	0	0	0	1



* Each TWT may have more than one failure code

AN/ALQ-131 OUTPUT TWTs

Screening Summary: Band 5 Varian (New) by Failure Codes



Total Failures	0	3	0	7	3	0	0	0	2	1	0	1

70 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 BLOCK I Band 3 LITTON Driver TWTs

Part Number	581R278H02 *	Vendor	LITTON
Stock Number	5865-01-045-6754EW	Band	3
New TWT	No	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
1.	10106	8745	FAIL	6,11,8		FF
2.	10139AR	8446	FAIL	11		AA
3.	10209BR	8604	FAIL	3, 5, 6		AA
4.	10212A	8745	FAIL	11, 12		FF
5.	10328	8745	FAIL	11, 6		FF
6.	10370BR	8446	FAIL	11, 6		AA
7.	10516R	8502	FAIL	7		AA
8.	10573R	8446	FAIL	6		FF
9.	10617R	8446	FAIL	11, 8, 4		AA
10.	13033BR	8608	FAIL	7		FF
11.	13078R	8446	FAIL	11		AA
12.	2664	8745	FAIL	11, 12		FF
13.	2816	8441	PASS			AA
14.	2817	8441	FAIL	3, 4, 6		AA
15.	3018R	8608	PASS			AA
16.	3072	8324	PASS			AA
17.	3176	8434	FAIL	6, 9		FF
18.	3207	8444	FAIL	6		FF
19.	3210	8441	PASS			AA
20.	3212	8444	FAIL	3, 6		AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 LITTON Driver TWTs

Part Number	581R278H02 *	Vendor	LITTON
Stock Number	5865-01-045-6754EW	Band	3
New TWT	No	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code*	System Test Results	TWT Status**
21.	3220	8444	PASS	1		AA
22.	3221	8445	FAIL	2, 4, 5		AA
23.	3233	8502	FAIL	7		FF
24.	3259	8509	PASS	1		AA
25.	3304	8540	FAIL	2, 4, 6		AA
26.	3326	8540	PASS			AA
27.	3327	8538	FAIL	6		FF
28.	3332	8540	FAIL	6, 7		FF
29.	3333	8551	FAIL	7		FF
30.	3334	8540	PASS	1, 2		AA
31.	3338	8542	PASS			AA
32.	3349	8550	FAIL	7		FF
33.	3353	8551	PASS			AA
34.	3355	8640	PASS			AA
35.	3358	8550	FAIL	14		AA
36.	3359	8551	PASS			AA
37.	3361	8604	FAIL	6, 7		AA
38.	3364	8551	PASS			AA
39.	3367	8551	PASS			AA
40.	3369	8604	FAIL	6		FF

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 LITTON Driver TWTs

Part Number .... 581R278H02 *
Stock Number 5865-01-045-6754EW
New TWT .... No

Vendor .... LITTON
Band 3
Block I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
41.	3370	8604	FAIL	2, 4		AA
42.	3373	8607	PASS			AA
43.	3374	8613	PASS	2		AA
44.	3383	8607	FAIL	3, 7		AA
45.	3385	8611	PASS	2		AA
46.	3387	8607	FAIL	6		FF
47.	3389	8607	PASS			AA
48.	3391	8613	FAIL	14		AA
49.	3394	8613	PASS			AA
50.	3396	8613	FAIL	2, 4		AA
51.	3397	8611	FAIL	12		AA
52.	3398	8616	PASS			AA
53.	3399	8613	FAIL	6, 10		FF
54.	3400	8616	PASS			AA
55.	3403	8613	PASS			AA
56.	3404	8616	PASS			AA
57.	3405	8613	FAIL	2, 4, 7		AA
58.	3407	8613	PASS			AA
59.	3410	8616	PASS			AA
60.	3414	8616	PASS	2		AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 LITTON Driver TWTs

Part Number	581R278H02 *	Vendor ...	LITTON
Stock Number	5865-01-045-6754EW	Band	3
New TWT	No	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
61.	3415	8619	PASS			AA
62.	3418	8619	PASS			AA
63.	3421	8619	PASS	2		AA
64.	3438	8625	PASS	1		AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 LITTON Driver TWTs

Part Number	581R279H02 *	Vendor	LITTON
Stock Number	5865-01-072-3490EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
1.	20333AR	8537	FAIL	1, 3, 13		AA
2.	20355AR	8537	FAIL	1, 2, 3		AA
3.	20547AR	8537	FAIL	1, 3		AA
4.	23024AR	8533	FAIL	1, 3, 9		AA
5.	23127AR	8507	PASS	1		AA
6.	3202	8524	PASS	1		AA
7.	3213	8509	PASS			AA
8.	3243	8534	PASS			AA
9.	3262	8520	PASS			AA
10.	3273	8523	PASS	1		AA
11.	3276	8524	PASS			AA
12.	3277	8524	PASS	1		AA
13.	3278	8524	PASS	1		AA
14.	3279	8524	PASS	1		AA
15.	3287	8529	PASS	1		AA
16.	3305	8533	PASS	1		AA
17.	3313	8536	PASS			AA
18.	3323	8540	PASS	1		AA
19.	3325	8537	FAIL	6		AA
20.	3333	8540	FAIL	1, 3		AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 LITTON Driver TWTs

Part Number .... 581R279H02 *
Stock Number 5865-01-072-3490EW
New TWT .... Yes

Vendor .... LITTON
Band 4
Block I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
21.	3337	8547	PASS	1		AA
22.	3340	8540	PASS	1		AA
23.	3346	8547	PASS			AA
24.	3352	8547	PASS	1		AA
25.	3354	8542	PASS			AA
26.	3356	8547	PASS	1, 2		AA
27.	3357	8540	PASS	1		AA
28.	3362	8546	PASS	1		AA
29.	3365	8547	PASS	1		AA
30.	3369	8604	FAIL	1, 3		AA
31.	3371	8547	PASS	1		AA
32.	3393	8615	PASS	1		AA
33.	3395	8604	FAIL	1, 3		AA
34.	3426	8611	PASS	1		AA
35.	3430	8616	FAIL	1		AA
36.	3431	8611	PASS	1		AA
37.	3432	8611	PASS			AA
38.	3434	8615	PASS	1		AA
39.	3436	8611	PASS			AA
40.	3438	8611	PASS	1		AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 LITTON Driver TWTs

Part Number	581R279H02 *	Vendor	LITTON
Stock Number	5865-01-072-3490EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
41.	3440	8611	PASS	1		AA
42.	3442	8611	PASS	1		AA
43.	3443	8615	PASS	1		AA
44.	3444	8616	PASS	1		AA
45.	3445	8616	PASS	1		AA
46.	3447	8615	PASS	1		AA
47.	3449	8615	PASS	1		AA
48.	3451	8615	PASS			AA
49.	3454	8616	PASS	1		AA
50.	3473	8620	PASS	1		AA
51.	3475	8620	FAIL	1, 3		AA
52.	3479	8620	PASS			AA
53.	3481	8620	FAIL	11		AA
54.	3482	8621	FAIL	1, 3, 7		AA
55.	3484	8620	PASS	1		AA
56.	3489	8620	PASS			AA
57.	3490	8620	PASS	1		AA
58.	3500	8620	PASS			AA
59.	3502	8638	PASS	1		AA
60.	3508	8704	PASS			AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 LITTON Driver TWTs

Part Number	581R279H02 *	Vendor	LITTON
Stock Number	5865-01-072-3490EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
61.	3523	8638	PASS			AA
62.	3544	8638	PASS			AA
63.	3548	8638	PASS	1		AA
64.	3553	8638	PASS			AA
65.	3357	8638	PASS			AA
66.	3565	8638	PASS	1		AA
67.	3566	8638	PASS	1		AA
68.	3567	8638	PASS	1		AA
69.	3568	8638	PASS	1		AA
70.	3570	8638	PASS	1		AA
71.	3578	8642	PASS			AA
72.	3585	8642	PASS	1		AA
73.	3591	8645	PASS			AA
74.	3596	8647	PASS			AA
75.	3599	8647	PASS			AA
76.	3600	8647	FAIL	1, 3, 5		AA
77.	3603	8647	PASS			AA
78.	3604	8704	PASS	1		AA
79.	3605	8711	PASS	1		AA
80.	3609	8647	PASS	1		AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 LITTON Driver TWTs

Part Number	581R279H02 *	Vendor	LITTON
Stock Number	5865-01-072-3490EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code*	System Test Results	TWT Status**
81.	3612	8704	PASS			AA
82.	3615	8651	PASS			AA
83.	3622	8704	PASS			AA
84.	3633	8651	PASS	1		AA
85.	3636	8704	PASS			AA
86.	3637	8703	PASS	1		AA
87.	3646	8704	FAIL	1, 3		AA
88.	3650	8704	FAIL	1, 3		FF
89.	3651	8704	PASS	1		AA
90.	3653	8704	PASS			AA
91.	3659	8703	PASS	1		AA
92.	3660	8704	FAIL	1, 3		AA
93.	3680	8711	FAIL	1, 3		AA
94.	3682	8711	FAIL	1, 3		AA
95.	3683	8711	FAIL	1, 3		AA
96.	3687	8711	PASS	1		AA
97.	3692	8715	PASS	1		AA
98.	3693	8712	PASS			AA
99.	3695	8715	PASS	1		AA
100.	3762	8737	PASS	1		AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 LITTON Driver TWTs

Part Number	581R279H02 *	Vendor	LITTON
Stock Number	5865-01-072-3490EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
101.	3789	8737	PASS			AA
102.	3796	8737	PASS	1		AA
103.	3840	8805	PASS	1		AA
104.	3844	8803	PASS	1		AA
105.	3846	8803	PASS	1		AA
106.	3848	8803	PASS	1		AA
107.	3857	8808	FAIL	1, 2, 4		AA
108.	3859	8750	PASS	1		AA
109.	3866	8803	PASS	1		AA
110.	3870	8803	FAIL	1, 6		AA
111.	3875	8803	PASS	1		AA
112.	3876	8803	PASS	1		AA
113.	3878	8804	FAIL	1, 7		AA
114.	3882	8807	PASS	1		AA
115.	3883	8807	PASS	1		AA
116.	3887	8808	FAIL	1, 3		AA
117.	3889	8807	PASS	1		AA
118.	3890	8808	FAIL	1, 9		AA
119.	3891	8808	PASS	1		AA
120.	3893	8814	PASS	1		AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 LITTON Driver TWTs

Part Number	581R279H02 *	Vendor ...	LITTON
Stock Number	5865-01-072-3490EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
121.	3896	8808	PASS	1		AA
122.	3899	8838	PASS	1		AA
123.	3907	8811	PASS	1		AA
124.	3911	8811	PASS	1		AA
125.	3912	8811	PASS	1		AA
126.	3915	8814	FAIL	1, 3		AA
127.	3933	8816	FAIL	1, 9		AA
128.	3941	8835	FAIL	9		AA
129.	3952	8838	FAIL	1, 9		AA
130.	3953	8835	PASS	1		AA
131.	3956	8835	PASS	1		AA
132.	3958	8835	PASS	1		AA
133.	3960	8835	PASS	1		AA
134.	3961	8835	PASS	1		AA
135.	3962	8838	PASS	1		AA
136.	3968	8838	FAIL	1, 3, 8		AA
137.	3969	8838	FAIL	1, 3		AA
138.	3970	8835	PASS	1		AA
139.	3972	8902	PASS	1		AA
140.	3990	8902	PASS	1		AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 4 LITTON Driver TWTs

Part Number	581R279H02 *	Vendor	LITTON
Stock Number	5865-01-072-3490EW	Band	4
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
141.	3998	8904	PASS	1		AA
142.	4001	8904	PASS			AA
143.	4002	8904	PASS			AA
144.	4003	8902	PASS			AA
145.	4005	8902	PASS			AA
146.	4006	8904	PASS	1		AA
147.	4009	8904	PASS	1		AA
148.	4010	8904	PASS	1		AA
149.	4011	8904	PASS	1		AA
150.	4012	8904	FAIL	11		FF

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
1.	3077R	8525	FAIL	1, 3, 5		ZZ
2.	3153R	8525	FAIL	1, 3, 7		AA
3.	3246	8546	FAIL	1, 3		AA
4.	3301	8509	PASS	1, 2		PP
5.	3335	8529	FAIL	1, 3, 5		ZZ
6.	3350	8525	FAIL	1, 3, 7	PASS	RT
7.	3358	8526	FAIL	1, 3		ZZ
8.	3381	8531	FAIL	1, 3		ZZ
9.	3397	8531	FAIL	1, 3		ZH
10.	3400	8531	FAIL	1, 3, 7		ZZ
11.	3404	8526	PASS	1		PP
12.	3405	8526	PASS	1		AA
13.	3417	8529	FAIL	3, 5, 7		ZZ
14.	3419	8529	FAIL	1, 7		ZH
15.	3428	8538	FAIL	1, 2, 3		RT
16.	3429	8531	FAIL	1, 3		ZZ
17.	3430	8531	PASS	1		AA
18.	3434	8538	FAIL	1, 2, 3		ZH
19.	3437	8538	FAIL	1, 2, 3		ZZ
20.	3438	8538	FAIL	1, 3, 7		ZZ

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
21.	3443	8540	FAIL	1, 6		ZZ
22.	3444	8545	PASS	1		AA
23.	3446	8538	FAIL	1, 3, 7		ZZ
24.	3455	8542	FAIL	1, 2, 3		ZZ
25.	3456	8545	FAIL	1, 3		AA
26.	3457	8545	FAIL	1, 3, 7		ZZ
27.	3461	8538	FAIL	1, 3, 4		AA
28.	3462	8538	FAIL	1, 3, 7		RT
29.	3465	8603	PASS	1, 2		AA
30.	3481	8542	PASS	1		AA
31.	3482	8545	FAIL	1, 3		ZZ
32.	3489	8545	FAIL	1, 3		ZH
33.	3494	8545	FAIL	1, 3		ZH
34.	3497	8545	FAIL	1, 3		AA
35.	3501	8545	FAIL	1, 3, 5		ZZ
36.	3508	8604	FAIL	1, 3, 7		ZH
37.	3510	8611	FAIL	3, 1		ZH
38.	35154CR	8507	FAIL	1, 2, 3		ZZ
39.	3517	8606	FAIL	1, 3, 7		ZH
40.	3519	8603	FAIL	3, 5, 7	PASS	ZH

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
41.	3521	8606	FAIL	1, 3, 7		ZH
42.	35233AR	8630	FAIL	1, 3, 5		ZH
43.	35247AR	8530	FAIL	1, 2, 3		ZZ
44.	35258AR	8530	FAIL	1, 2, 3		ZZ
45.	35309AR	8542	FAIL	1, 2, 3		RT
46.	3531	8603	PASS	1		AA
47.	35325AR	8530	FAIL	1, 3, 7		RT
48.	35348R	8647	FAIL	1, 3, 7		ZH
49.	3542	8606	FAIL	1, 3, 7		ZH
50.	3543	8603	FAIL	3, 7, 1		ZH
51.	35465R	8633	FAIL	3, 5, 7		RT
52.	3549	8606	FAIL	3, 1, 7		ZH
53.	35510CR	8525	FAIL	1, 3, 7		ZZ
54.	3554	8608	PASS	1		AA
55.	35549CR	8530	FAIL	3, 5, 7		ZZ
56.	35575CR	8525	FAIL	1, 3, 7	FAIL	ZH
57.	35587CR	8542	FAIL	1, 3, 4		ZH
58.	3561	8606	FAIL	1, 3, 5		ZH
59.	3562	8606	PASS	1		AA
60.	3564	8606	FAIL	11		FF

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
61.	3565	8613	FAIL	3, 5, 7		RT
62.	3566	8611	FAIL	3, 7, 1		ZH
63.	3567	8608	PASS	1		AA
64.	3568	8608	FAIL	1, 7		AA
65.	3569	8611	FAIL	1, 3		ZH
66.	3570	8606	FAIL	1, 3, 7		AA
67.	3572	8611	PASS	1		AA
68.	3578	8611	FAIL	14		FF
69.	3585	8611	FAIL	3, 5, 7		ZH
70.	3590	8611	FAIL	3, 2, 1		RT
71.	3591	8611	PASS	1		AA
72.	3592	8611	PASS	1		AA
73.	3599	8611	FAIL	1, 3	PASS	ZH
74.	3602	8614	FAIL	3, 7, 1		ZH
75.	3606	8614	PASS	1		AA
76.	3609	8616	FAIL	1, 3		ZZ
77.	3610	8614	FAIL	1, 8		AA
78.	3617	8613	PASS	1		AA
79.	3622	8624	FAIL	3, 2, 1		ZH
80.	3627	8624	FAIL	1, 3, 14		FF

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
81.	3630	8624	FAIL	1, 3, 7		ZH
82.	3648	8624	FAIL	1, 3		ZH
83.	3650	8624	FAIL	1, 3, 7		ZH
84.	3655	8624	PASS	1		AA
85.	3657	8630	FAIL	1, 7		ZH
86.	3658	8624	PASS	1		AA
87.	3659	8624	FAIL	1, 3, 7		ZH
88.	3662	8624	FAIL	1, 3		ZZ
89.	3664	8624	FAIL	1, 3		AA
90.	3666	8630	PASS	1		AA
91.	3667	8630	FAIL	1, 2, 6		AA
92.	3688	8630	FAIL	1, 3		ZH
93.	3689	8630	FAIL	3, 1		AA
94.	3690	8630	FAIL	1, 3		ZH
95.	3703	8651	PASS	1		AA
96.	3705	8637	FAIL	1, 3		ZH
97.	3707	8641	PASS	1		AA
98.	3708	8643	PASS	1		AA
99.	3709	8645	FAIL	1, 3	PASS	ZH
100.	3720	8704	FAIL	1, 3		ZH

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
101.	3724	8637	FAIL	1, 3, 7		ZH
102.	3726	8637	PASS	1		AA
103.	3727	8641	FAIL	3, 7, 1		ZH
104.	3728	8641	PASS	1		AA
105.	3731	8641	FAIL	1, 2, 3		ZH
106.	3734	8649	PASS	1		AA
107.	3744	8641	PASS	1		AA
108.	3748	8646	PASS	1		AA
109.	3752	8703	FAIL	1, 2, 3		ZH
110.	3758	8645	PASS	1		AA
111.	3759	8645	PASS	1		AA
112.	3762	8646	PASS	1		AA
113.	3763	8645	FAIL	3, 1		AA
114.	3764	8645	FAIL	3, 1		ZH
115.	3765	8646	PASS	1		AA
116.	3766	8646	FAIL	1, 3		AA
117.	3769	8651	PASS	1		AA
118.	3772	8704	FAIL	1, 3, 7		RT
119.	3773	8649	PASS	1	PASS	AA
120.	3777	8645	FAIL	3, 7, 1		ZH

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
121.	3778	8649	FAIL	1, 3		RT
122.	3780	8646	FAIL	1, 3, 7		ZH
123.	3781	8646	FAIL	1, 3, 7		ZH
124.	3782	8646	FAIL	1, 3		AA
125.	3783	8651	PASS	1		AA
126.	3785	8646	PASS	1		AA
127.	3786	8647	FAIL	1, 3		ZH
128.	3787	8651	FAIL	1, 3, 7		AA
129.	3790	8647	FAIL	3, 1, 2		ZH
130.	3791	8649	PASS	1		AA
131.	3792	8649	PASS	1		AA
132.	3794	8649	PASS	1		AA
133.	3797	8651	FAIL	3, 1, 5		ZH
134.	3799	8651	PASS	1		AA
135.	3800	8651	FAIL	3, 1, 7		AA
136.	38017AR	8542	FAIL	1, 3, 7		ZH
137.	3802	8651	PASS	1		AA
138.	3803	8651	PASS	1		AA
139.	38033AR	8530	FAIL	1, 2, 3		ZZ
140.	3804	8651	FAIL	3, 1		ZH

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
141.	38046CR	8525	PASS	1		AA
142.	3805	8651	FAIL	7, 1		ZH
143.	3809	8651	FAIL	3, 1		AA
144.	3810	8704	FAIL	1, 3		ZH
145.	3811	8651	FAIL	1, 7		AA
146.	3812	8721	FAIL	3, 5, 7		RT
147.	3813	8703	FAIL	1, 3, 6		ZH
148.	3814	8703	FAIL	1, 3		ZH
149.	3816	8704	FAIL	1, 3		RT
150.	3817	8651	PASS	1		AA
151.	3818	8704	PASS	1, 2		AA
152.	3819	8708	FAIL	1, 3, 7		ZH
153.	3821	8651	PASS	1		AA
154.	3822	8704	PASS			AA
155.	3823	8703	FAIL	1, 2, 3		ZH
156.	3824	8703	FAIL	1, 2, 3		AA
157.	3825	8703	FAIL	1, 3		ZH
158.	3826	8704	PASS	1		AA
159.	3829	8703	FAIL	1, 2, 3	FAIL	RT
160.	3830	8704	FAIL	1, 2, 3	PASS	ZH

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
161.	3831	8703	FAIL	1, 3, 7		AA
162.	3832	8704	FAIL	1, 3, 7		ZH
163.	3833	8704	FAIL	1, 2, 3		ZH
164.	3834	8704	FAIL	1, 2, 3		ZH
165.	3835	8704	FAIL	1, 2, 3		ZH
166.	3837	8704	FAIL	1, 3		ZH
167.	3838	8704	FAIL	1, 3, 7		ZH
168.	3839	8708	FAIL	1, 2, 3		ZH
169.	3840	8712	PASS	1		AA
170.	3842	8712	FAIL	3, 7, 1		ZH
171.	3844	8712	FAIL	3, 1, 2		RT
172.	3851	8708	FAIL	1, 3, 7		ZH
173.	3858	8717	FAIL	1, 3		RT
174.	3861	8717	FAIL	1, 2, 3		ZH
175.	3862	8712	FAIL	3, 1		ZH
176.	3863	8712	FAIL	3, 1		ZH
177.	3868	8712	PASS	1		AA
178.	3872	8712	PASS	1		AA
179.	3873	8712	PASS	1		AA
180.	3874	8715	PASS	1		AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
181.	3875	8712	FAIL	1, 2, 3		AA
182.	3876	8715	FAIL	3, 1		AA
183.	3877	8712	PASS	1		AA
184.	3878	8712	PASS	1		AA
185.	3879	8712	FAIL	1, 3		ZH
186.	3882	8712	PASS	1		AA
187.	3883	8712	FAIL	1, 3, 7		ZH
188.	3884	8712	FAIL	1, 3		ZH
189.	3885	8712	FAIL	1, 2, 3		RT
190.	3886	8715	PASS	1		AA
191.	3899	8712	FAIL	1, 3		AA
192.	3907	8717	FAIL	3, 1, 2		ZH
193.	3909	8721	FAIL	3, 1, 7		ZH
194.	3913	8717	PASS	1, 2		AA
195.	3922	8721	FAIL	1, 3, 7		ZH
196.	3924	8721	FAIL	1, 3, 5		ZH
197.	3926	8721	PASS			AA
198.	3933	8803	FAIL	3, 7, 1		ZH
199.	3934	8721	FAIL	3, 7, 1		RT
200.	3936	8742	FAIL	3, 1, 7		ZH

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number .... 581R280H04 * Vendor .... LITTON
Stock Number .... 5865-01-054-4781EW Band 5
New TWT .... Yes Block I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
201.	3937	8721	FAIL	1, 3, 7		ZH
202.	3939	8721	FAIL	3, 1, 7		ZH
203.	3940	8724	FAIL	1, 2, 3		ZH
204.	3943	8724	FAIL	3, 1, 2		ZH
205.	3944	8721	FAIL	3, 5, 7		ZH
206.	3948	8724	FAIL	1, 2, 3		ZH
207.	3950	8724	FAIL	3, 5, 7		RT
208.	3967	8724	FAIL	3, 2, 1		RT
209.	3971	8724	FAIL	1, 3		ZH
210.	3978	8729	FAIL	1, 2, 3		ZH
211.	3986	8741	FAIL	3, 1, 7		ZH
212.	4026	8741	FAIL	3, 1, 5		ZH
213.	4036	8741	FAIL	1, 3		AA
214.	4049	8803	FAIL	3, 5, 7	FAIL	ZH
215.	4084	8803	FAIL	3, 5, 7		RT
216.	4091	8803	PASS	1, 2		AA
217.	4092	8803	PASS	1		AA
218.	4099	8847	FAIL	3, 5, 7		ZH
219.	4104	8815	FAIL	1, 2, 3		RT
220.	4105	8751	FAIL	3, 1, 7		ZH

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
221.	4108	8751	FAIL	3, 2, 1		ZH
222.	4109	8815	FAIL	1, 2, 3		ZH
223.	4110	8751	FAIL	3, 1, 7		ZH
224.	4112	8751	FAIL	3, 1		ZH
225.	4113	8751	PASS	1		AA
226.	4114	8751	PASS	1		AA
227.	4117	8751	FAIL	3, 1, 7		ZH
228.	4121	8751	PASS	1		AA
229.	4123	8803	PASS	1, 2		AA
230.	4124	8803	FAIL	3, 7, 1		ZH
231.	4129	8803	FAIL	3, 2, 1		AA
232.	4132	8803	FAIL	1, 3, 7		ZH
233.	4165	8842	FAIL	1, 2, 4		ZH
234.	4173	8812	PASS	1		AA
235.	4183	8815	FAIL	1, 3	FAIL	ZH
236.	4185	8815	FAIL	1, 3		RT
237.	4187	8816	FAIL	1, 2, 3		ZH
238.	4192	8815	FAIL	1, 3, 5		RT
239.	4197	8815	PASS	1		AA
240.	4198	8816	FAIL	1, 3		ZH

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
241.	4199	8816	FAIL	1, 3, 7		ZH
242.	4200	8816	FAIL	1, 3		ZH
243.	4203	8816	FAIL	1, 3		ZH
244.	4205	8842	FAIL	3, 1, 5		RT
245.	4246	8830	FAIL	3, 1		ZH
246.	4247	8846	PASS	1, 2		AA
247.	4249	8842	FAIL	3, 1		ZH
248.	4252	8830	FAIL	3, 1, 2		ZH
249.	4262	8830	FAIL	1, 2, 5		ZH
250.	4264	8830	FAIL	3, 1		ZH
251.	4266	8830	FAIL	3, 1		AA
252.	4270	8842	FAIL	3, 5, 7		RT
253.	4271	8830	FAIL	1, 3		ZH
254.	4274	8831	FAIL	3, 1, 6		ZH
255.	4276	8842	FAIL	3, 1, 6		ZH
256.	4287	8843	FAIL	4, 2		FF
257.	4289	8843	FAIL	3, 5, 7		RT
258.	4293	8838	FAIL	3, 1		ZH
259.	4296	8843	FAIL	3, 2, 1		ZH
260.	4298	8842	FAIL	3, 1		AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
261.	4301	8843	FAIL	3, 1, 5		RT
262.	4303	8843	FAIL	1, 2, 3		ZH
263.	4304	8842	FAIL	3, 1, 6		ZH
264.	4308	8842	FAIL	1, 3		ZH
265.	4309	8843	FAIL	3, 5, 1		RT
266.	4311	8847	FAIL	3, 1		ZH
267.	4312	8842	FAIL	3, 1		ZH
268.	4313	8851	FAIL	3, 5, 7		ZH
269.	4314	8842	FAIL	3, 7, 6		ZH
270.	4315	8843	FAIL	3, 1, 7		ZH
271.	4316	8843	FAIL	3, 1, 2		ZH
272.	4317	8847	FAIL	3, 1		ZH
273.	4318	8843	FAIL	3, 1, 6		AA
274.	4319	8843	FAIL	3, 7, 1		ZH
275.	4321	8843	FAIL	3, 2, 1		RT
276.	4323	8843	FAIL	3, 1		RT
277.	4325	8843	FAIL	3, 6, 1		AA
278.	4326	8843	FAIL	3, 1, 7	PASS	RT
279.	4327	8843	FAIL	1, 2, 3		AA
280.	4329	8846	FAIL	3, 1		ZH

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 5 LITTON Driver TWTs

Part Number	581R280H04 *	Vendor	LITTON
Stock Number	5865-01-054-4781EW	Band	5
New TWT	Yes	Block	I

Item Number	Serial Number	Date Code	ETM Screening Results	Primary Failure Code**	System Test Results	TWT Status **
281.	4332	8851	FAIL	1, 3, 7		RT
282.	4334	8847	FAIL	3, 1		ZH
283.	4336	8847	PASS	1		AA
284.	4337	8851	FAIL	1, 3		ZH
285.	4338	8847	FAIL	3, 1		ZH
286.	4339	8847	FAIL	1, 3		ZH
287.	4340	8847	FAIL	1, 3, 6		AA
288.	4341	8847	FAIL	3, 1		ZH
289.	4342	8847	FAIL	3, 5, 7		RT
290.	4343	8851	FAIL	3, 2, 1		ZH
291.	4346	8851	PASS	1		AA
292.	4347	8852	FAIL	3, 5, 7		ZH
293.	4348	8851	FAIL	3, 1, 6		ZH
294.	4369	8921	FAIL	3, 5, 7		RT
295.	4382	8921	PASS	1		AA
296.	4385	8916	FAIL	3, 9, 1		ZH
297.	4389	8915	FAIL	3, 7, 1		RT
298.	4395	8915	FAIL	3, 1, 7		ZH
299.	4404	8925	FAIL	3, 1		ZH
300.	4430	8947	PASS	1		AA

* Sorted by part number.
** Failure codes & status codes are located on last page of this attachment.

Driver TWT Program Summary Report

I. Fielded Band 3 Litton Driver TWTs:

Quantity screened 64
Quantity passed 30
Quantity failed 34

Failure rate 53.1%

Review Board Results:

- Quantity reviewed 34
- Quantity passed 18
- Quantity failed 16
- Quantity pending 0
- Awaiting Review 0

Overall Program Results:

- Quantity received 64
- Quantity screened 64
- Quantity condition code A 48
- Condition code A rate 75.0%

II. New Band 4 Litton Driver TWTs:

Quantity screened 150
Quantity passed 119
Quantity failed 31

Failure rate 20.7%

Review Board Results:

- Quantity reviewed 31
- Quantity passed 29
- Quantity failed 2
- Quantity pending 0
- Awaiting Review 0

Overall Program Results:

- Quantity received 150
- Quantity screened 150
- Quantity condition code A 148
- Condition code A rate 98.7%

III. New Band 5 Litton Driver TWTs:

Quantity screened 300
Quantity passed 71
Quantity failed 229

Failure rate 76.3%

System Test Results:

- Quantity tested 11
- Quantity passed 7
- Quantity failed 4

Review Board Results:

- Quantity reviewed ... 206
- Quantity passed 31
- Quantity failed 4
- Quantity pending 171
- Awaiting review 23

Overall Program Results:

- Quantity received 300
- Quantity screened 300
- Quantity condition code A 102
- Condition code A rate 34.0%

Driver TWT Failure Codes

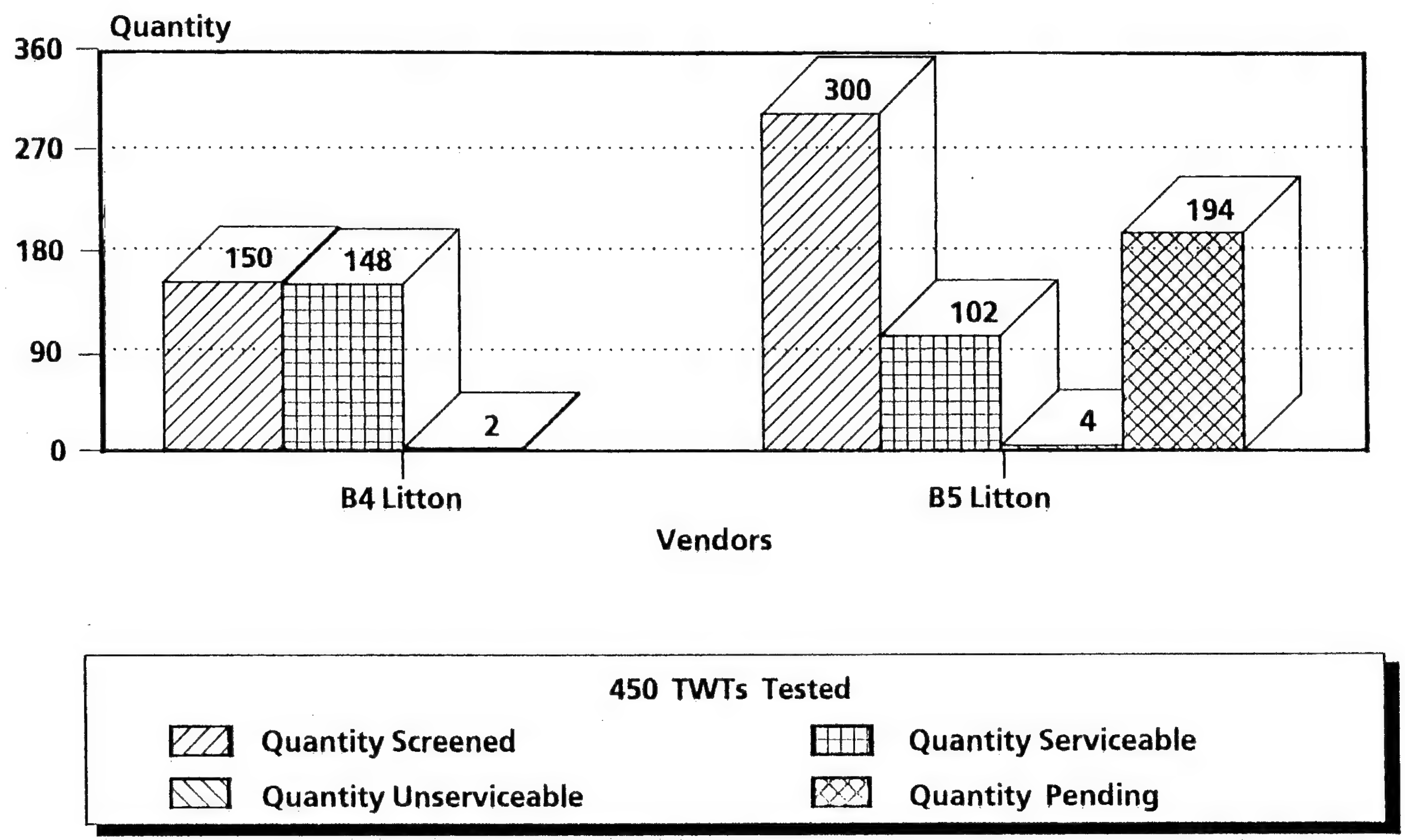
1. 1st stage three (3) minute gain
2. 2nd stage three (3) minute gain
3. 1st stage thirty (30) minute gain
4. 2nd stage thirty (30) minute gain
5. 1st stage power
6. 2nd stage power
7. 1st stage noise figure
8. 2nd stage noise figure
9. 1st stage gain variation
10. 2nd stage gain variation
11. 1st stage inoperative
12. 2nd stage inoperative
13. Mechanical
14. Other

TWT Status Codes

1. AA - Serviceable TWT
2. FF - Unserviceable TWT
3. ZM - Recommend return to manufacturer
4. FRB - Requires Retesting for additional information
5. ZS - Requires system testing
6. ZH - Hold pending other test results
7. ZZ - Awaiting review from FRB
8. PP - Awaiting disposition
9. RT-Requires Retesting

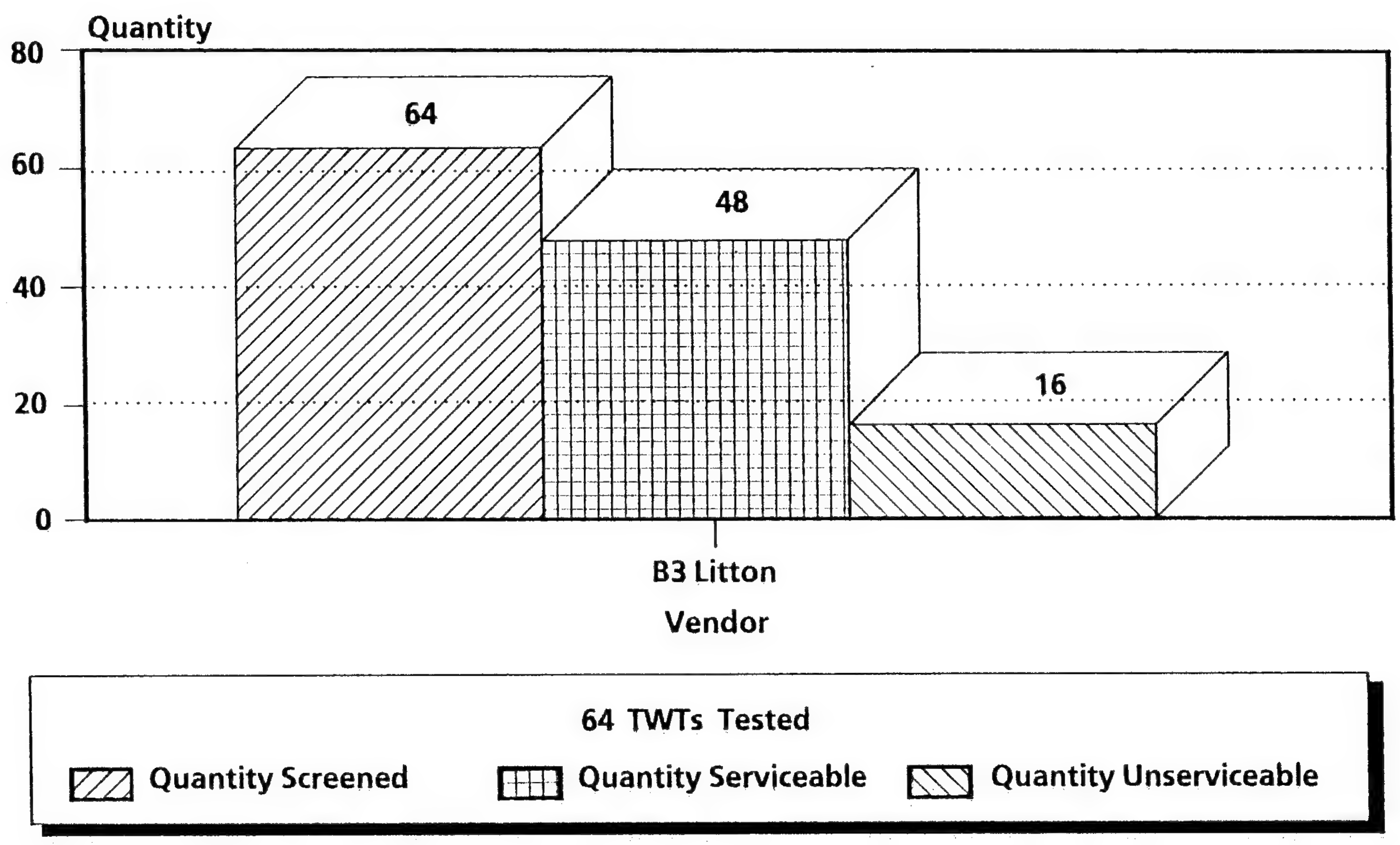
AN/ALQ-131 DRIVER TWTs

Program Summary: New Band 4 and 5 TWTs



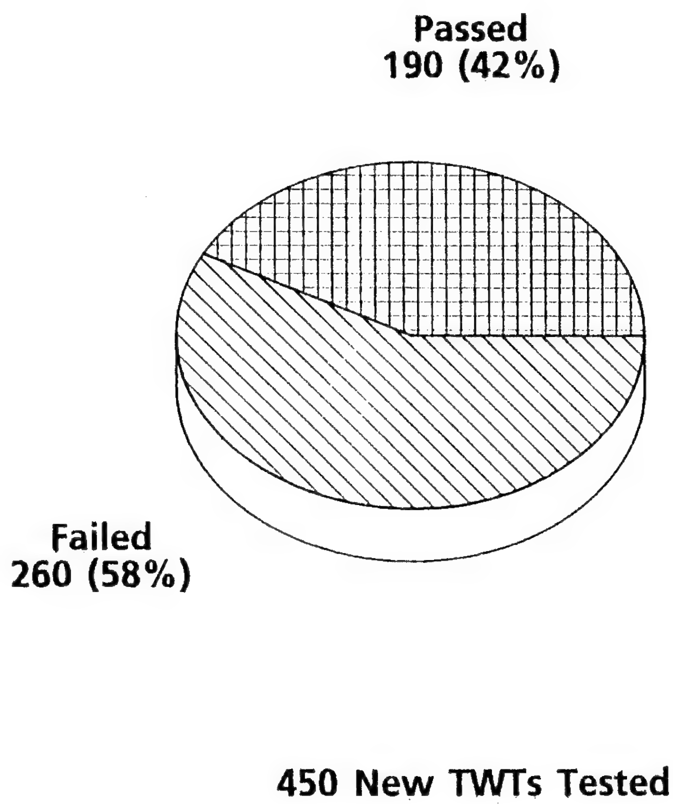
AN/ALQ-131 DRIVER TWTs

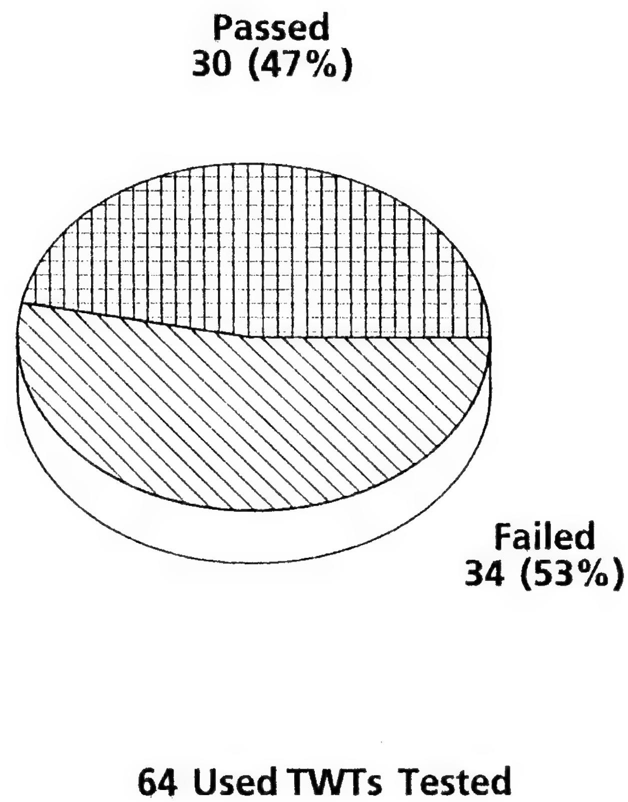
Program Summary: Used Band 3 TWTs



AN/ALQ-131 DRIVER TWTs

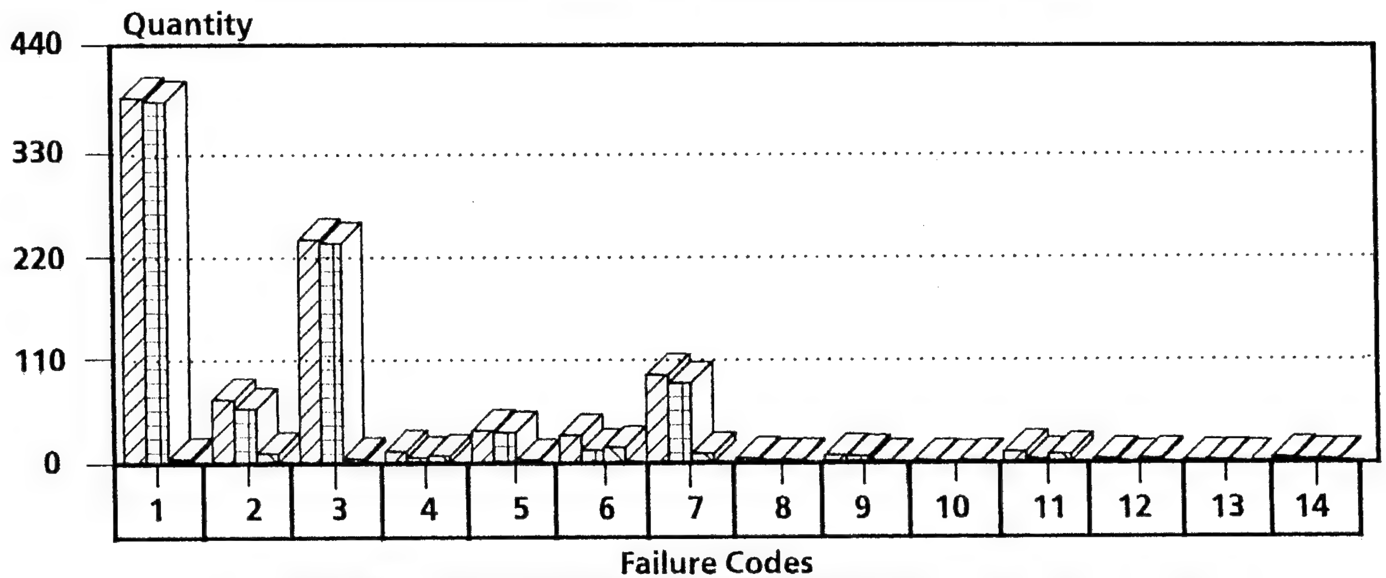
Screening Summary: New vs. Used





AN/ALQ-131 DRIVER TWTs

Screening Summary: New vs. Used by Failure Code



	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Total Failures	392	68	240	12	34	29	94	4	7	1	11	3	1	4
New TWT Failures	388	58	236	5	32	13	85	2	6	0	3	0	1	2
Used TWT Failures	4	10	4	7	2	16	9	2	1	1	8	3	0	2

Screening Results

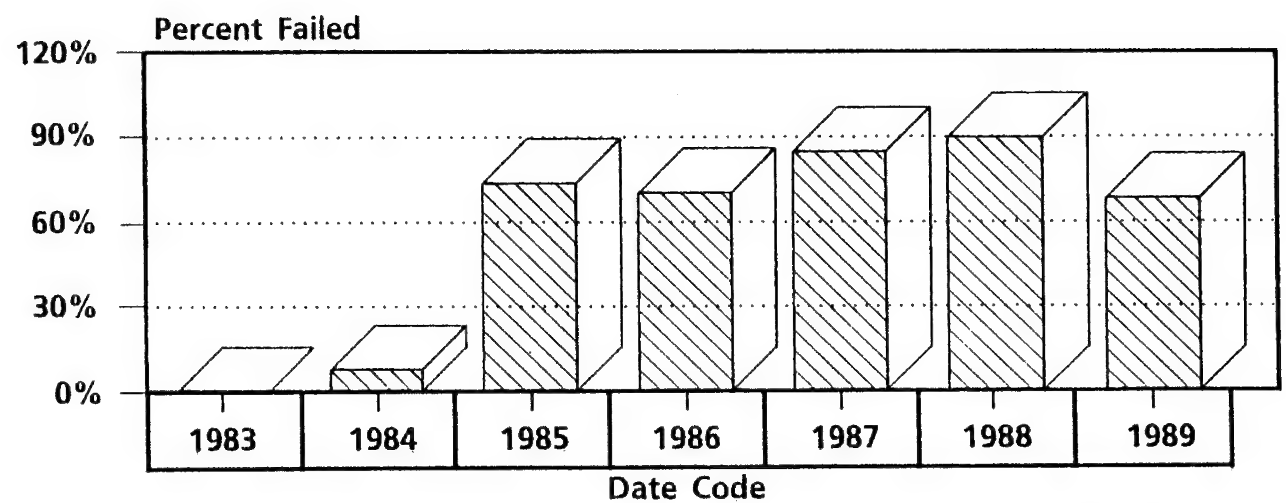
Total Failures | New TWT Failures | Used TWT Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 1)



Percent Failed/Year	0%	7.7%	73.9%	70.5%	84.8%	89.8%	68.4%

514 TWTs Screened

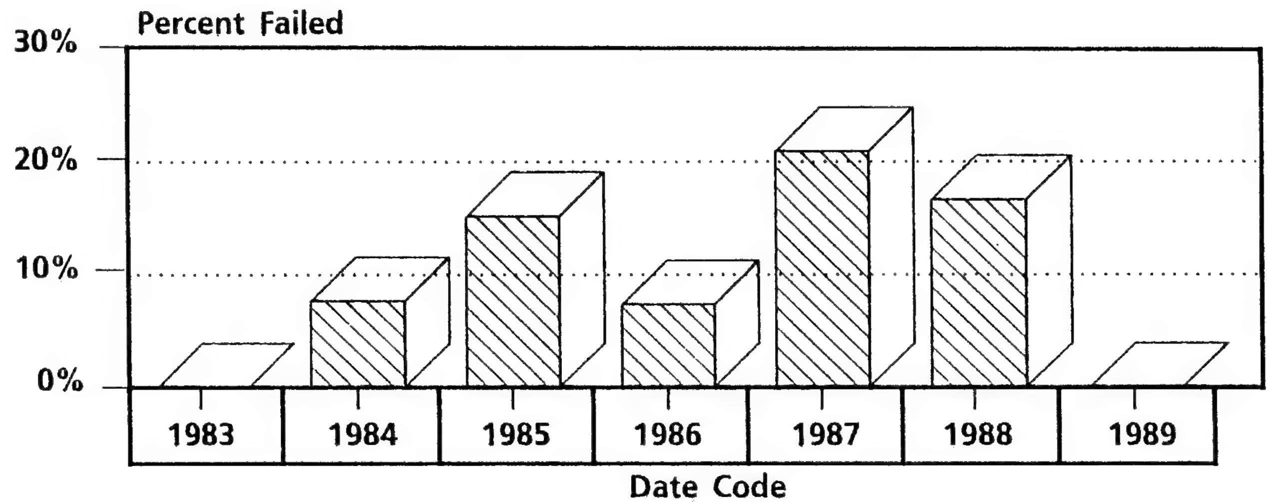
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 2)



Percent Failed/Year	0%	7.7%	15.2%	7.4%	21%	16.7%	0%

514 TWTs Screened

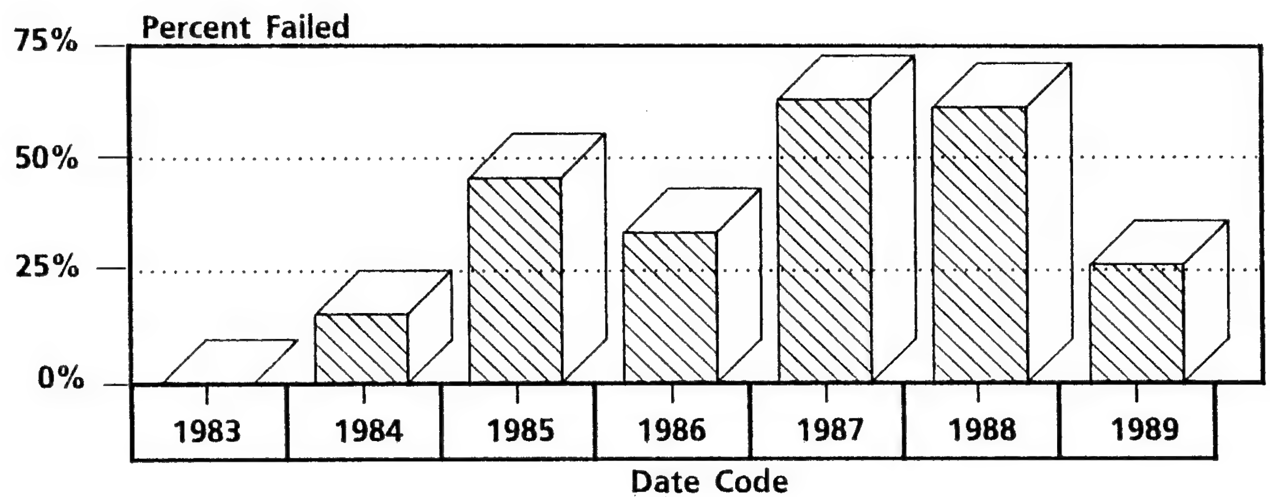
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 3)



Percent Failed/Year	0%	15.4%	45.7%	33.5%	62.9%	61.1%	26.3%

514 TWTs Screened

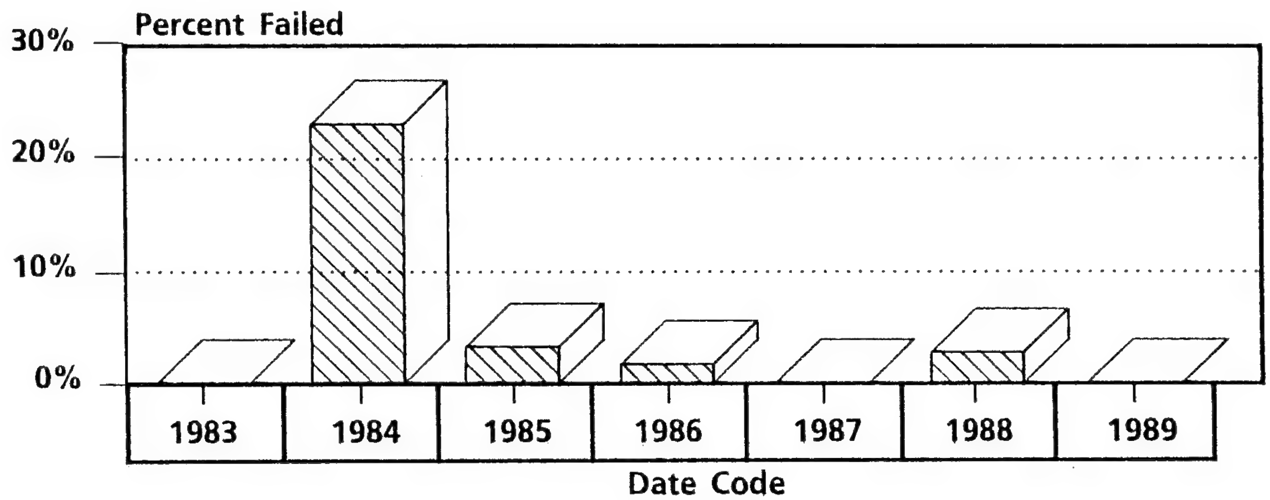
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 4)



Percent Failed/Year	0%	23.1%	3.3%	1.7%	0%	2.8%	0%

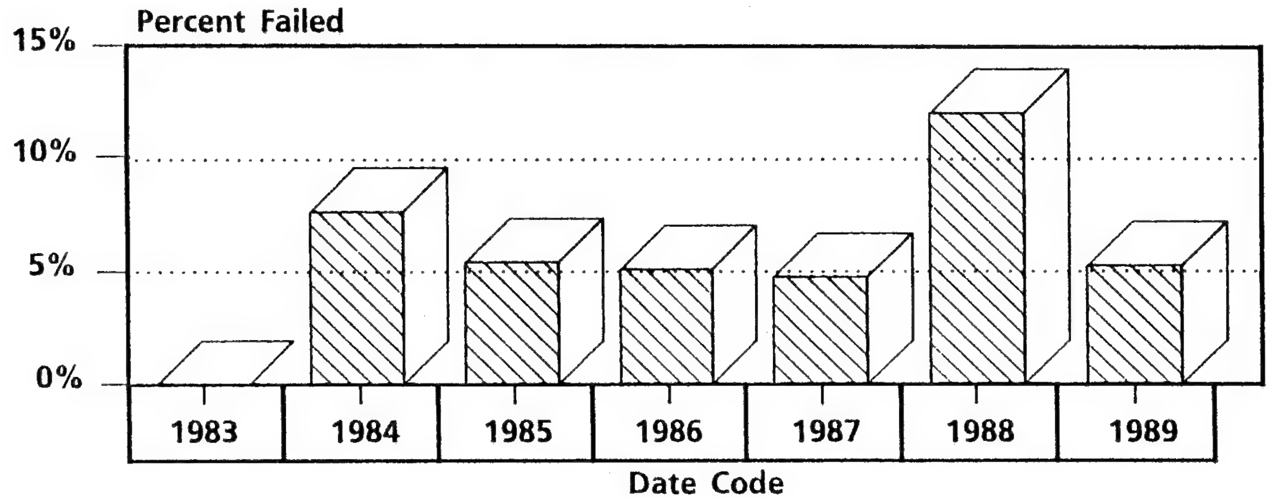
514 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 5)



Percent Failed/Year	0%	7.7%	5.4%	5.1%	4.8%	12%	5.3%

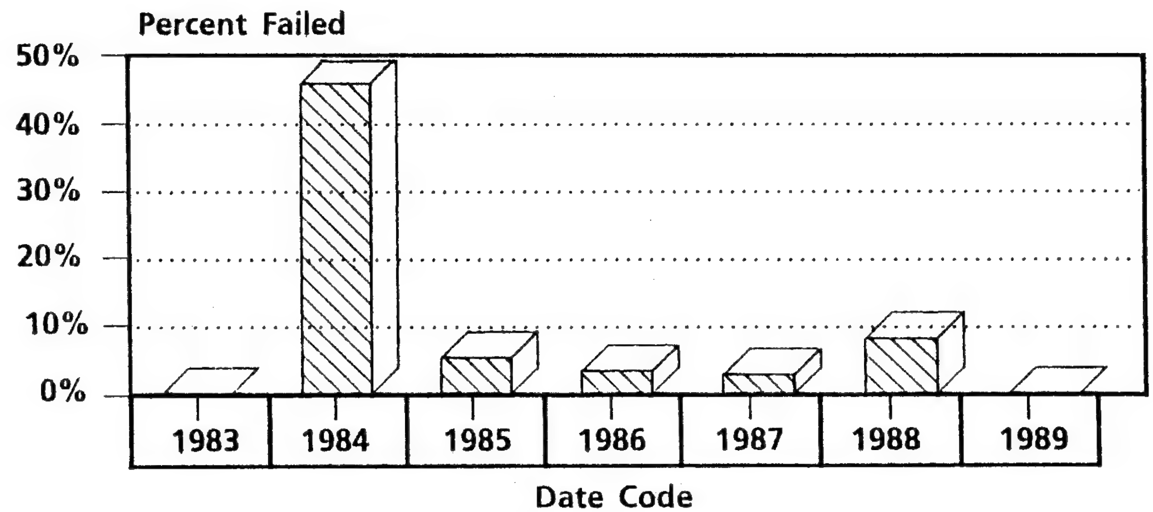
514 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 6)



Percent Failed/Year	0%	46.2%	5.4%	3.4%	2.9%	8.3%	0%

514 TWTs Screened

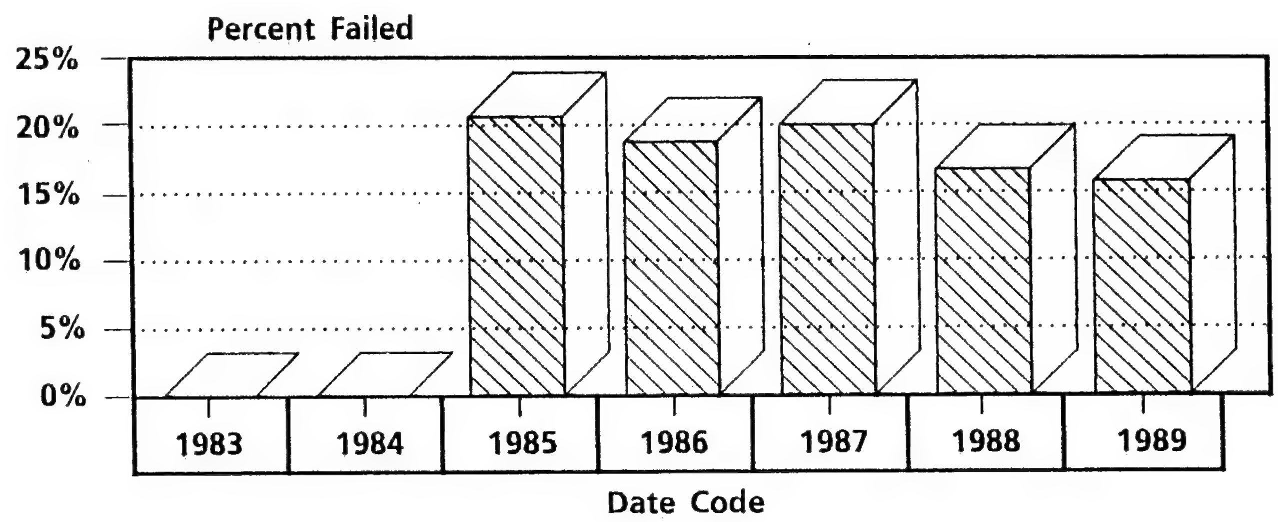
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 7)



Percent Failed/Year	0%	0%	20.7%	18.8%	20%	16.7%	15.3%

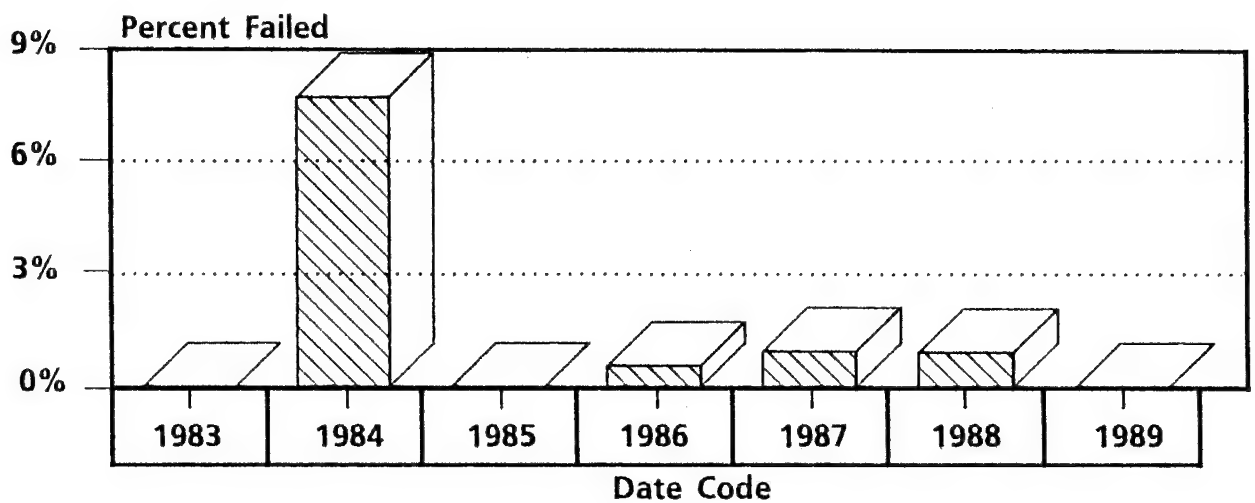
514 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 8)



Percent Failed/Year	0%	7.7%	0%	0.6%	1%	0.9%	0%

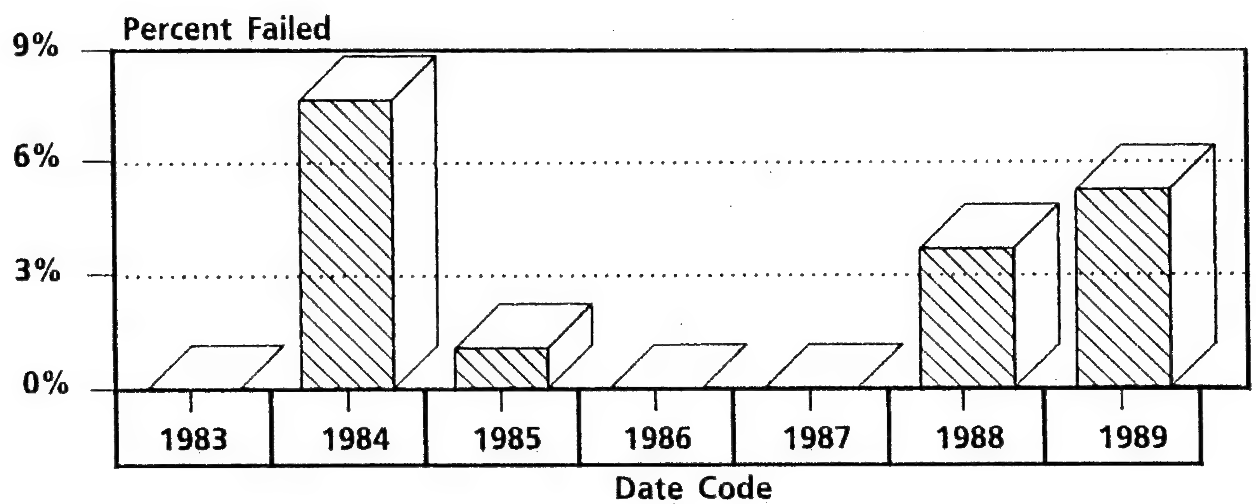
514 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 9)



Percent Failed/Year	0%	7.7%	1.1%	0%	0%	3.7%	5.3%

514 TWTs Screened

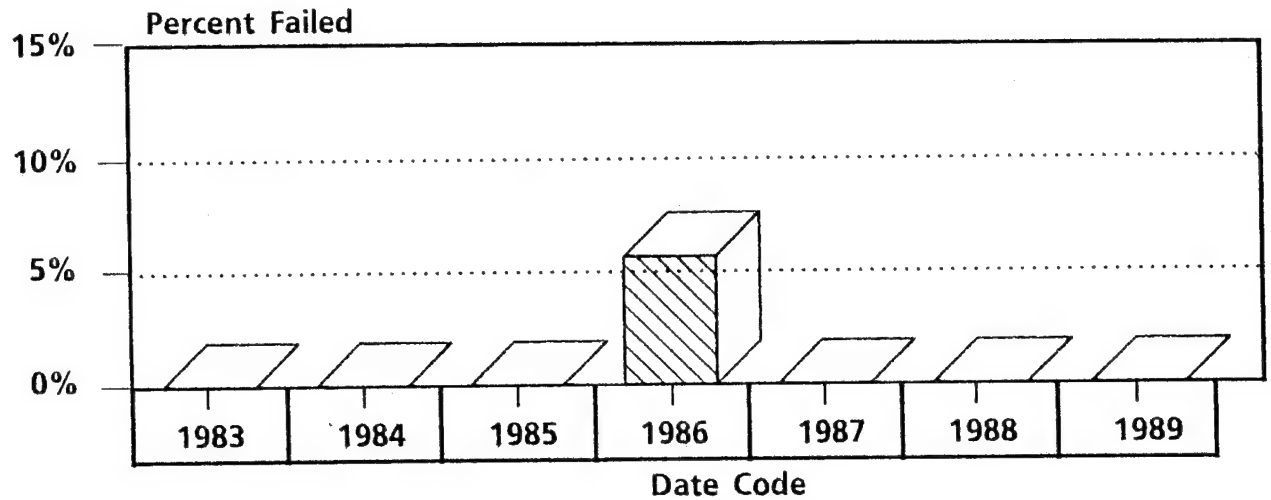
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 10)



Percent Failed/Year	0%	0%	0%	0.6%	0%	0%	0%

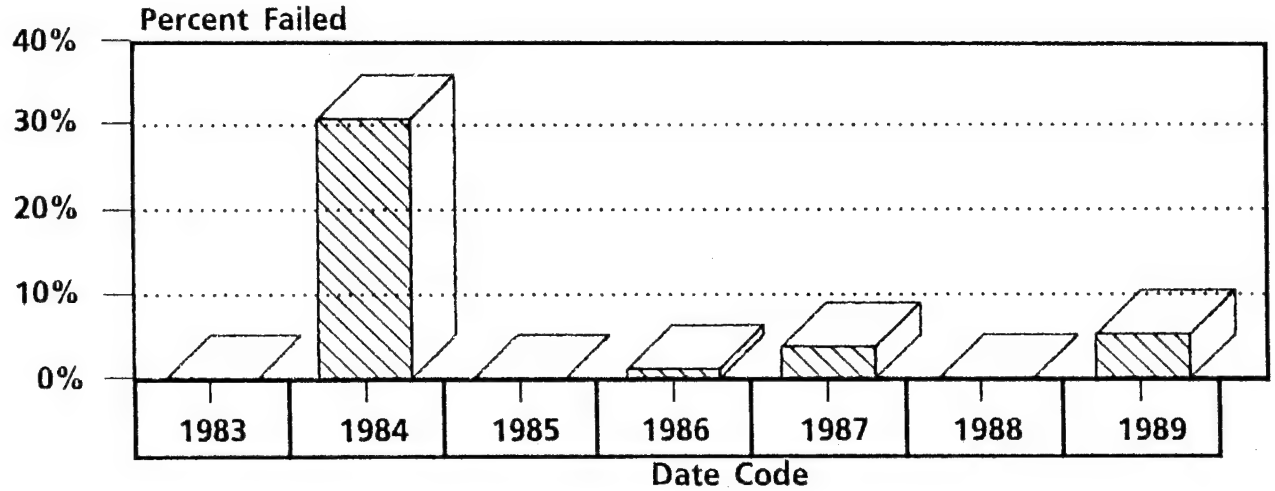
514 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 11)



Percent Failed/Year	0%	30.8%	0%	1.1%	3.8%	0%	5.3%

514 TWTs Screened

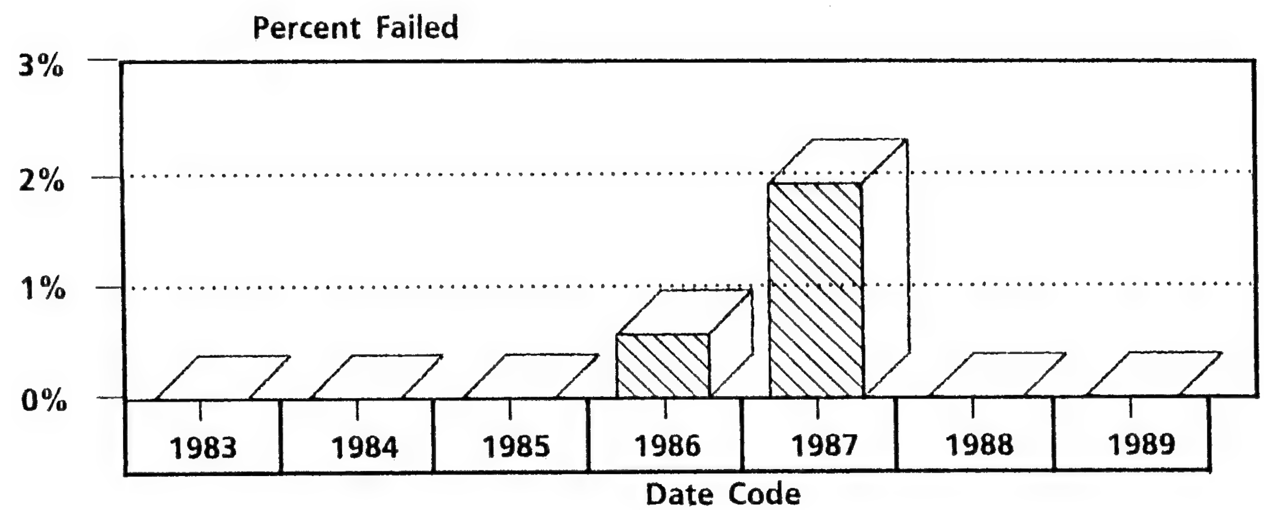
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 12)



Percent Failed/Year	0%	0%	0%	0.6%	1.9%	0%	0%

514 TWTs Screened

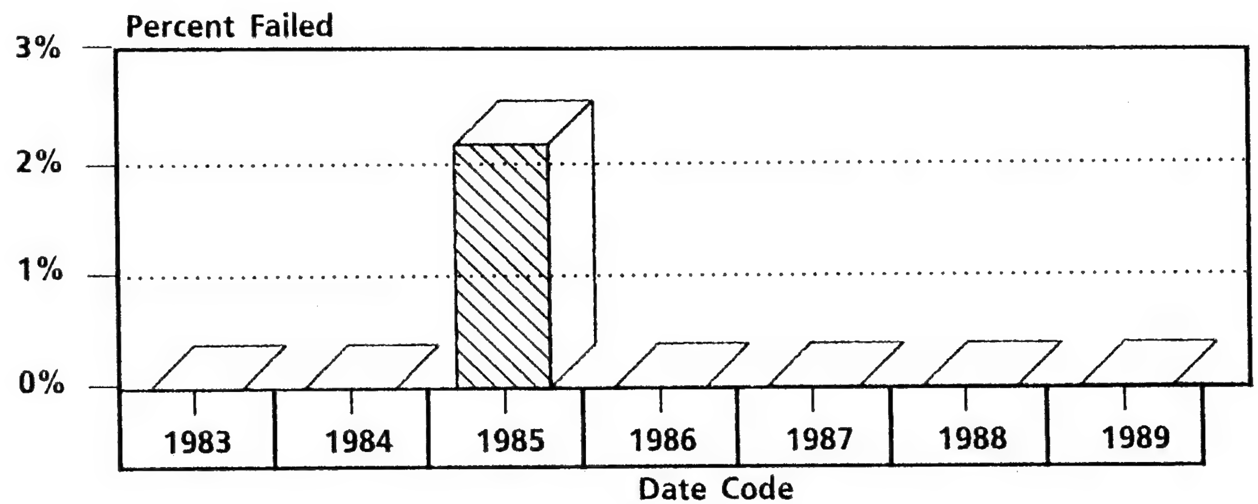
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 13)



Percent Failed/Year	0%	0%	1.1%	0%	0%	0%	0%

514 TWTs Screened

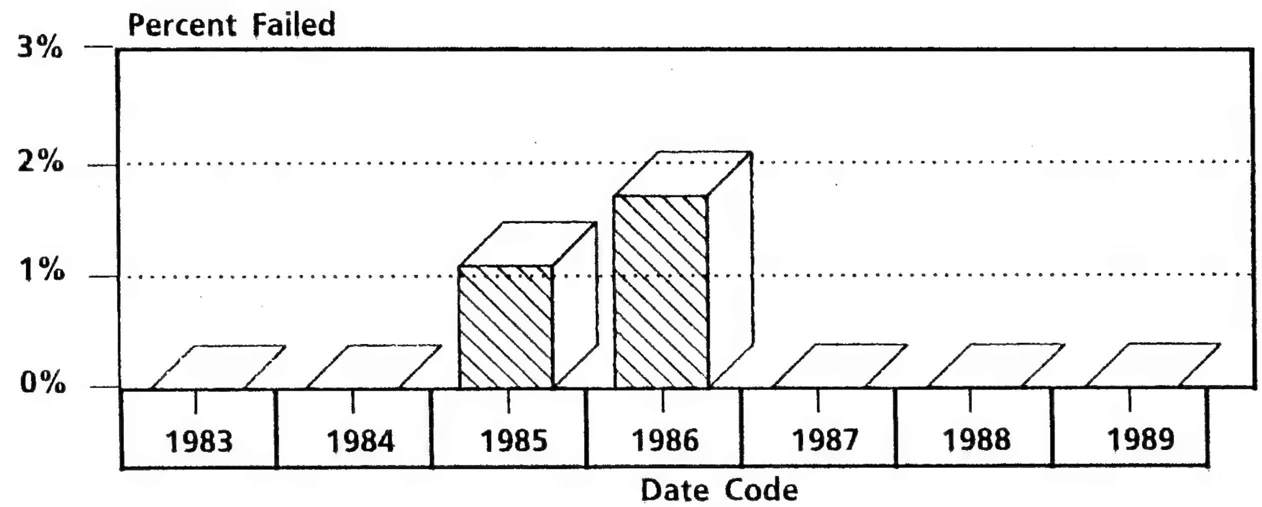
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3, 4, and 5
(Failure Code 14)



	1983	1984	1985	1986	1987	1988	1989
Percent Failed/Year	0%	0%	1.1%	1.7%	0%	0%	0%

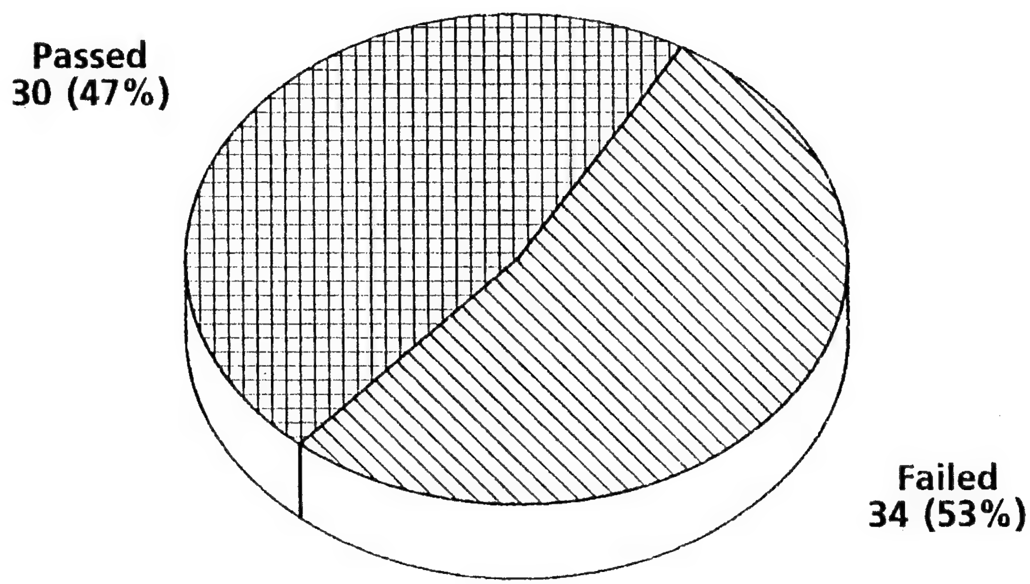
514 TWTs Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

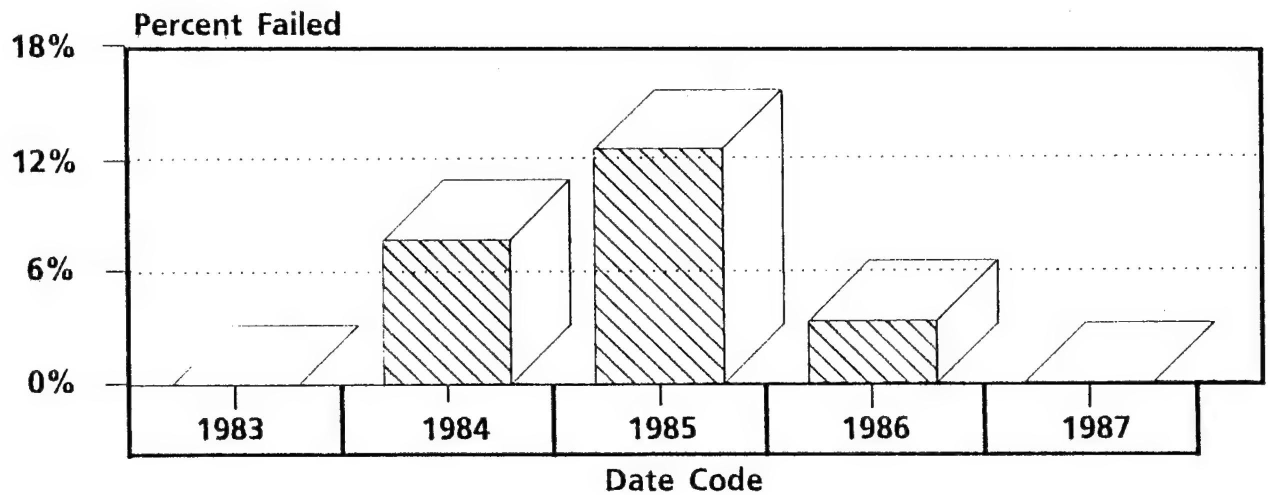
Screening Summary: Band 3 Litton (Used)



64 TWTs Tested

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 1)



Percent Failed/Year	0%	7.7%	12.5%	3.3%	0%

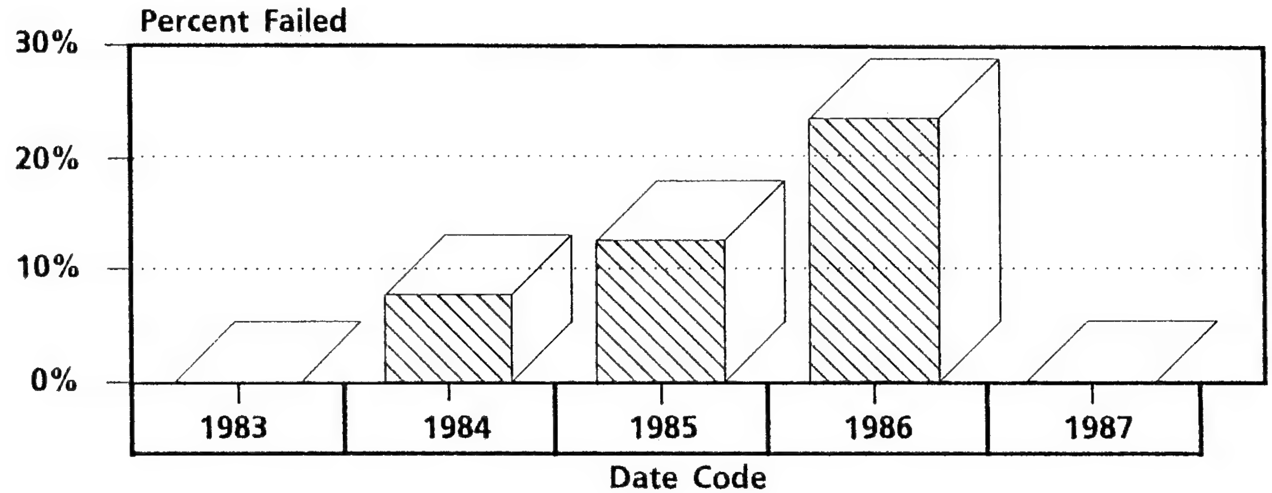
64 TWT Tested

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 2)

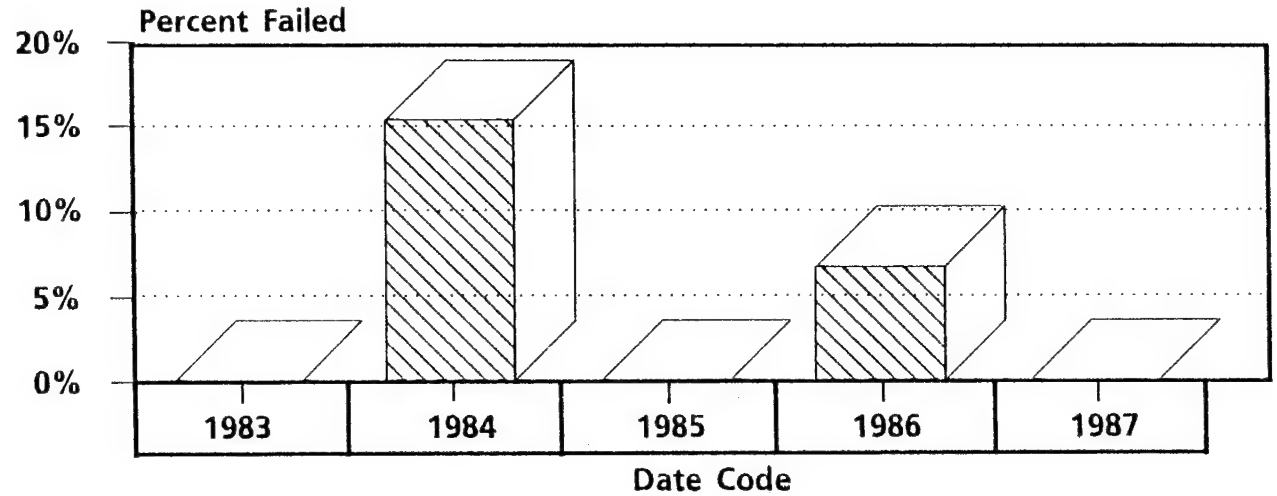


Percent Failed/Year	0%	7.7%	12.5%	23.3%	0%

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 3)



Percent Failed/Year	0%	15.4%	0%	6.7%	0%

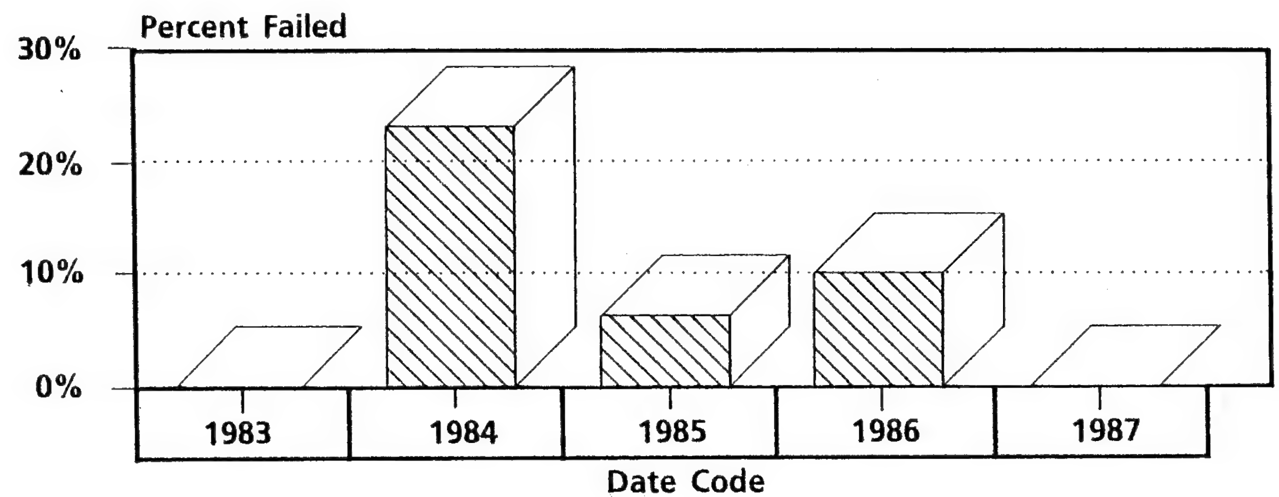
64 TWT Tested

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 4)

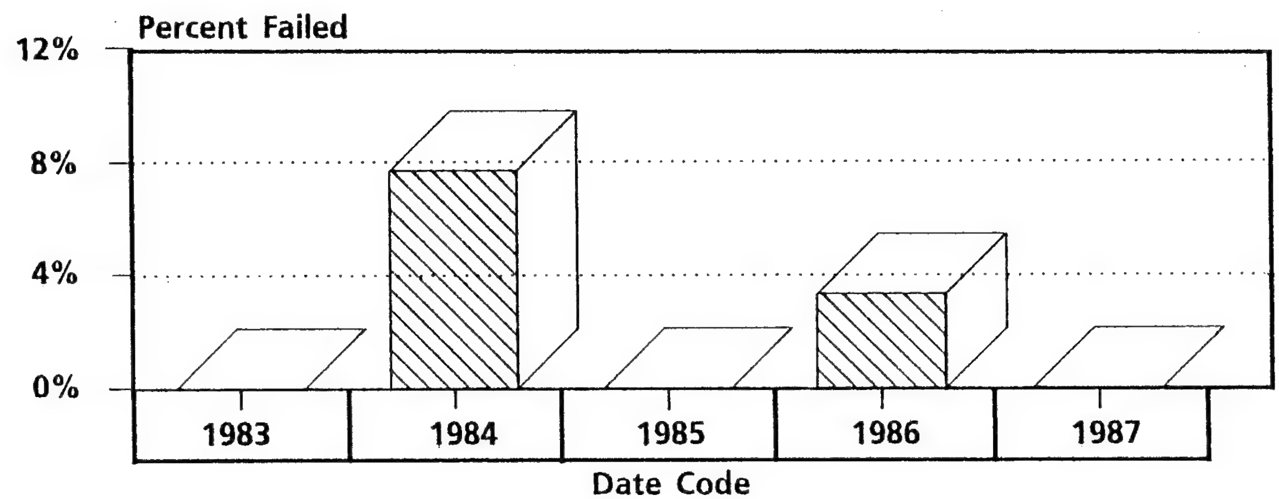


Percent Failed/Year	0%	23.1%	6.3%	10%	0%

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 5)



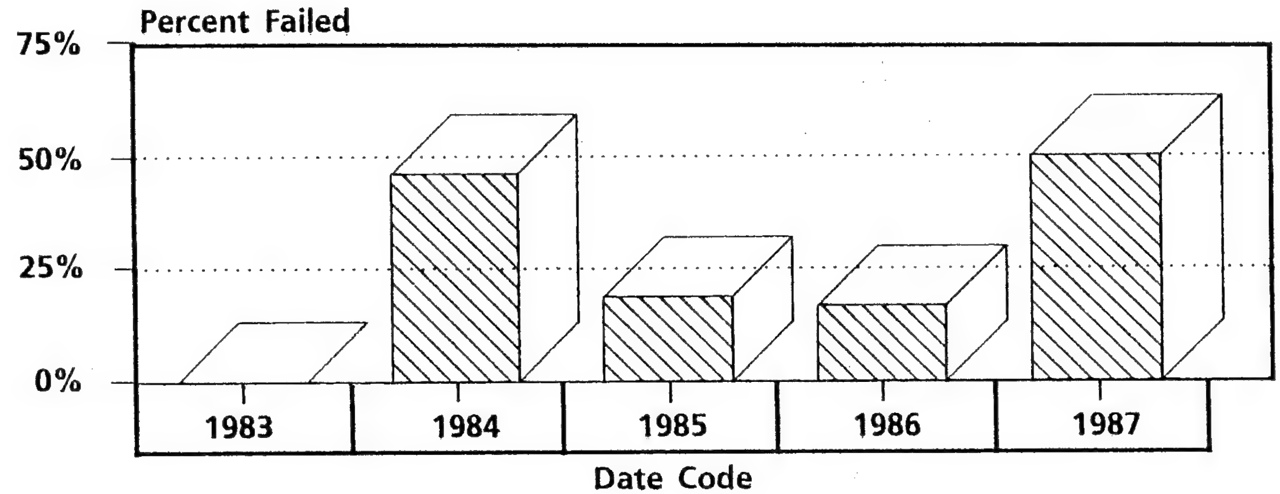
Percent Failed/Year	0%	7.7%	0%	3.3%	0%

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 6)

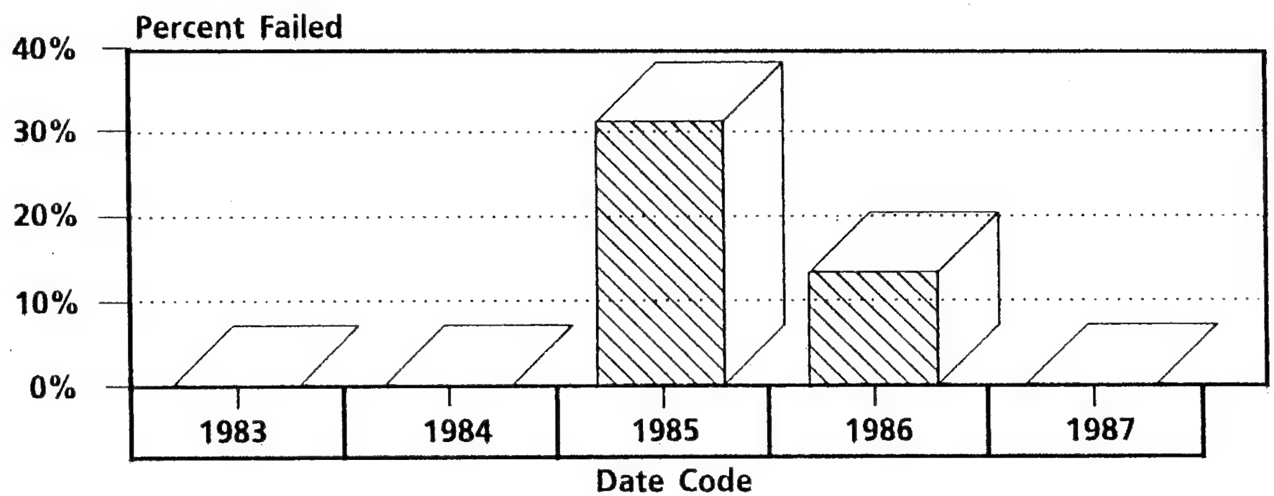


Percent Failed/Year	0%	46.2%	18.8%	16.7%	50%

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 7)



Percent Failed/Year	0%	0%	31.3%	13.3%	0%

64 TWT Tested

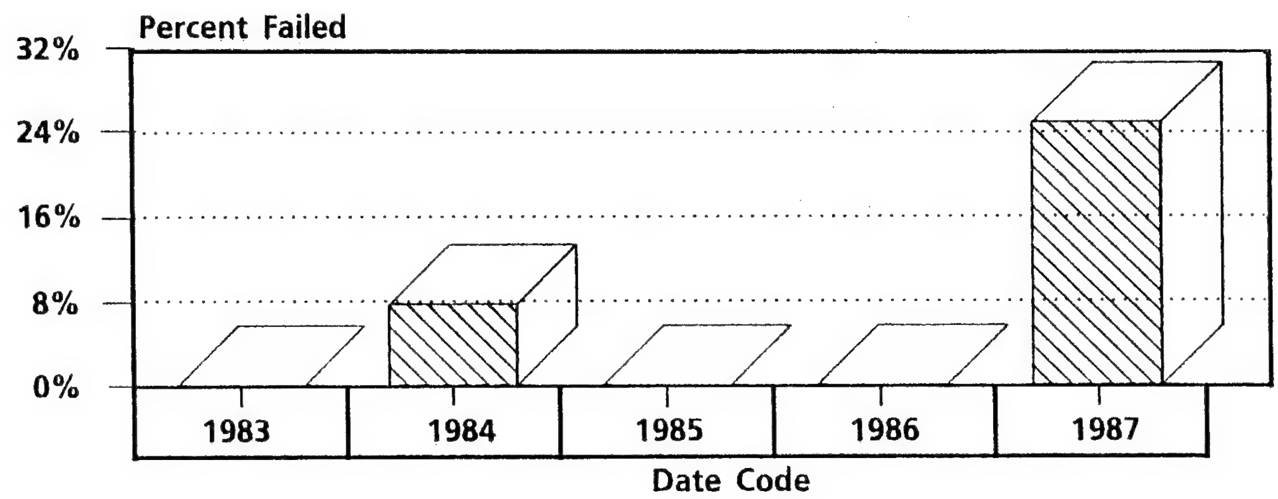
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 8)



Percent Failed/Year	0%	7.7%	0%	0%	25%

64 TWT Tested

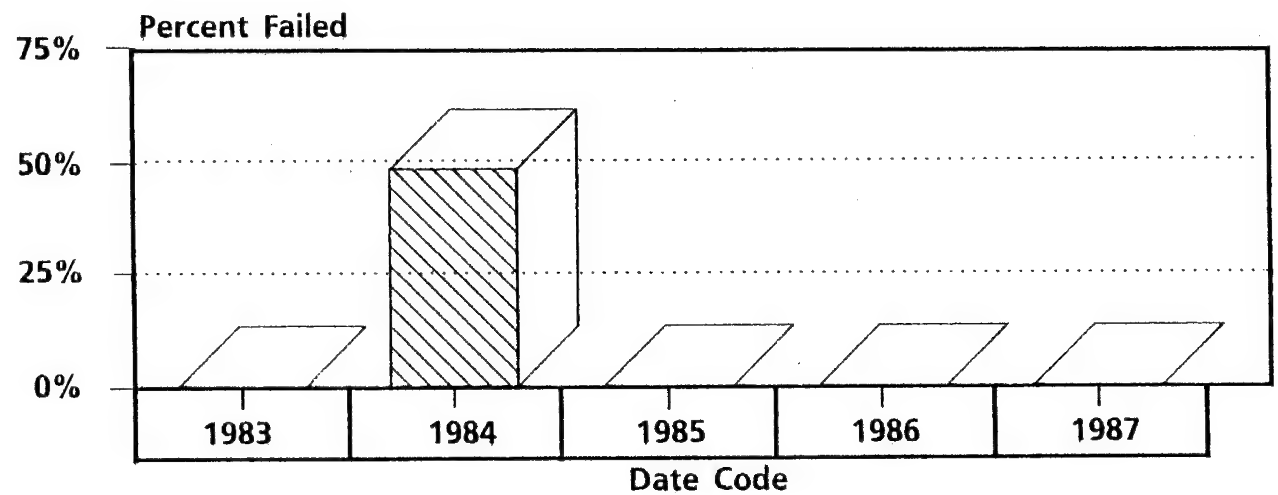
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 9)



Percent Failed/Year	0%	7.7%	0%	0%	0%

64 TWT Tested

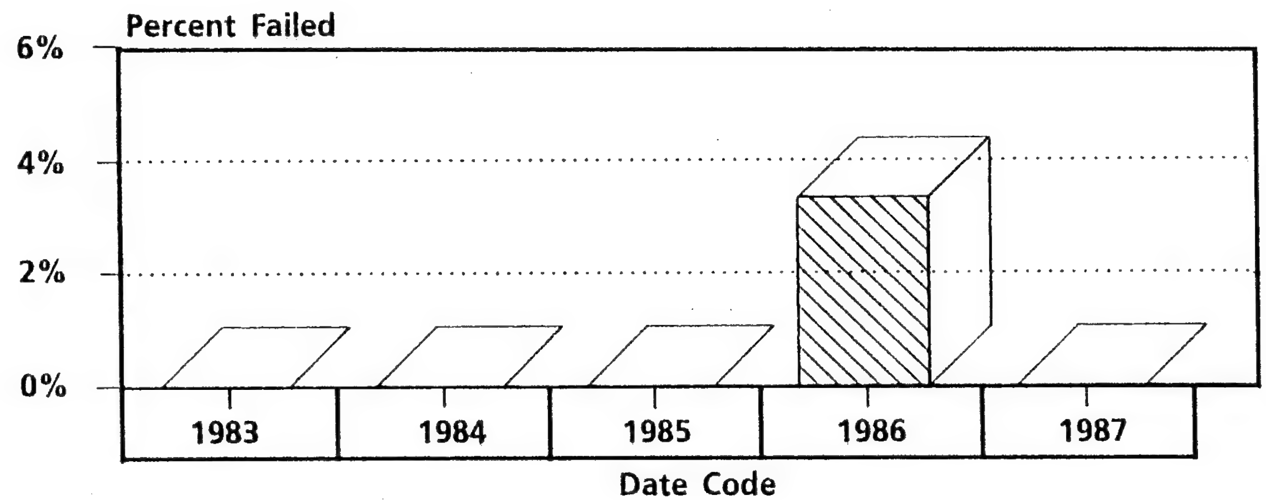
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 10)



Percent Failed/Year	0%	0%	0%	3.3%	0%

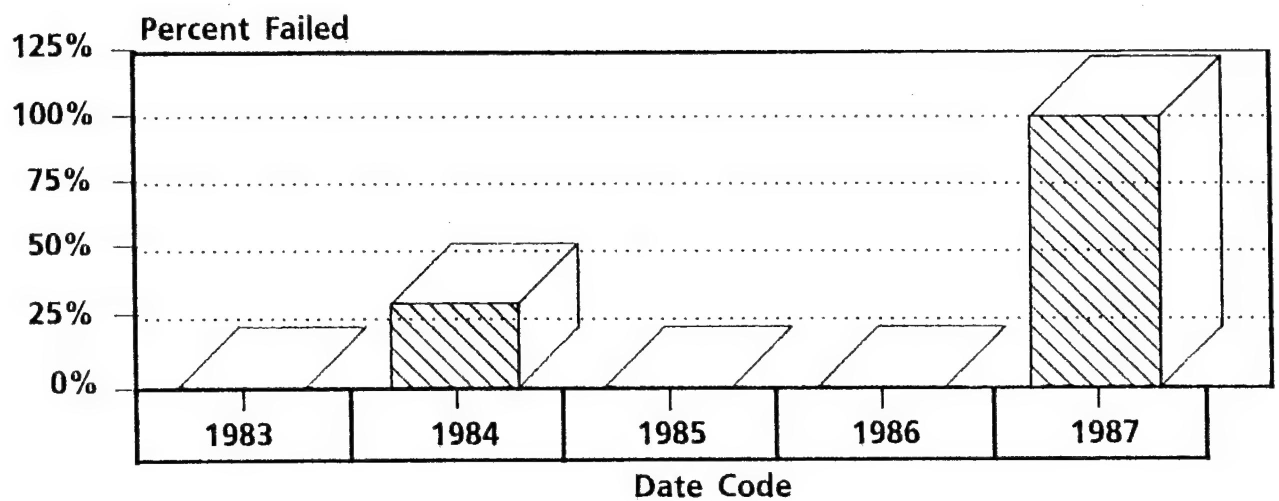
64 TWT Tested

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 11)



Percent Failed/Year	0%	30.8%	0%	0%	100%

64 TWT Tested

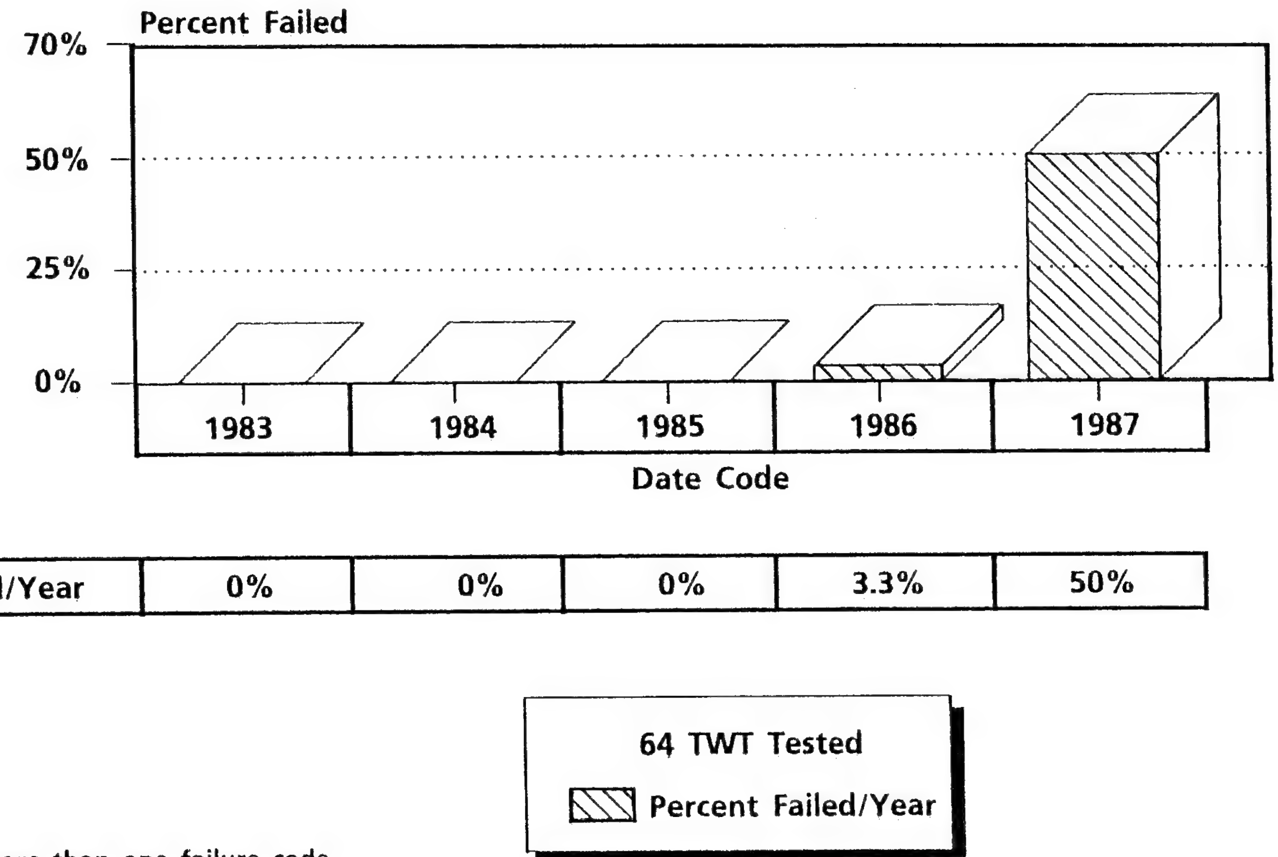
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 12)

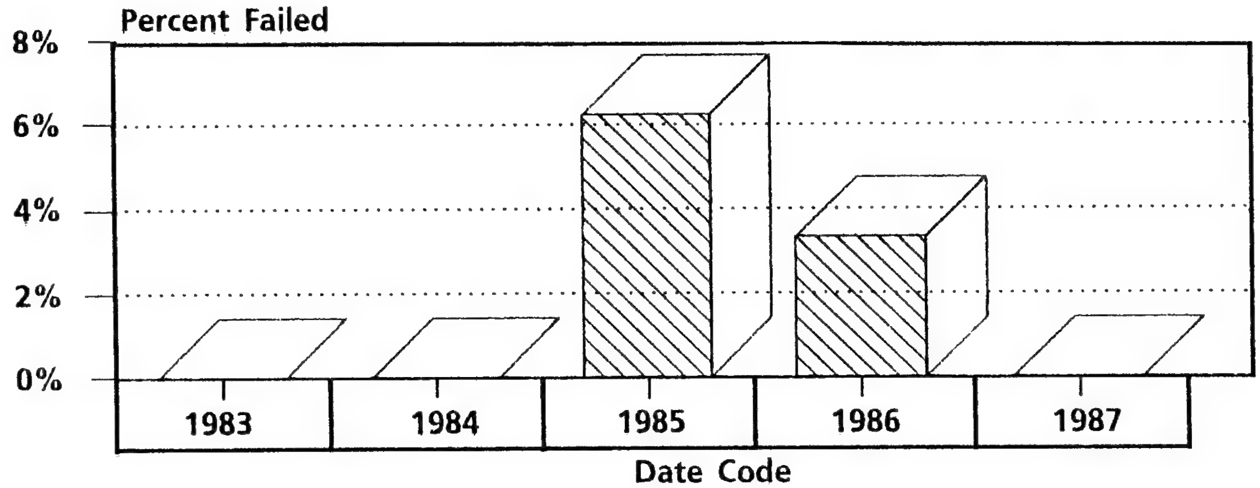


Percent Failed/Year	0%	0%	0%	3.3%	50%

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(Failure Code 14)



Percent Failed/Year	0%	0%	6.3%	3.3%	0%

64 TWT Tested

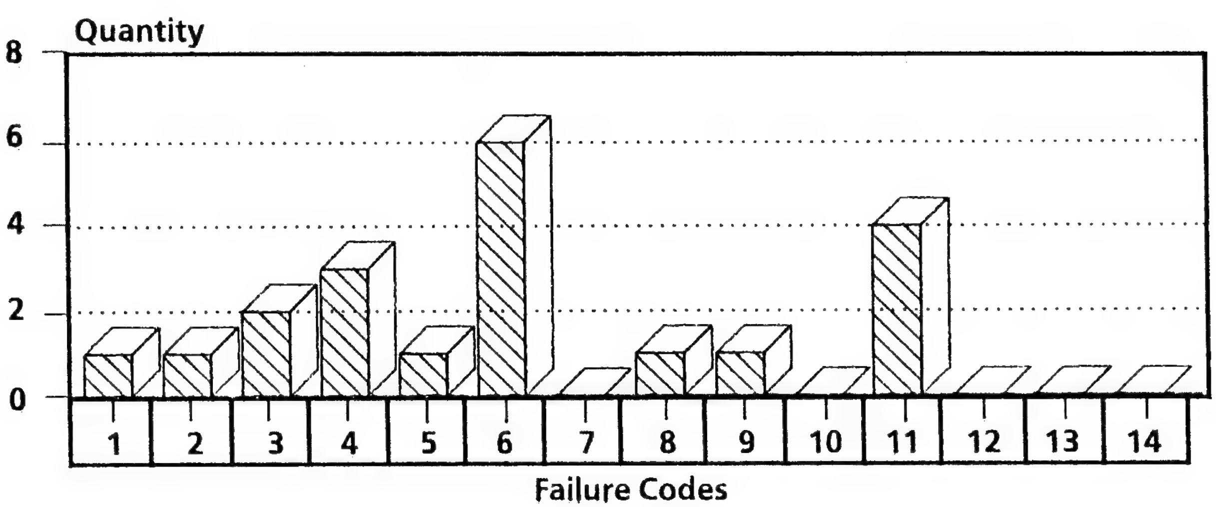
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(1984 Date Code)



Total Failures	1	1	2	3	1	6	0	1	1	0	4	0	0	0

13 TWTs Tested

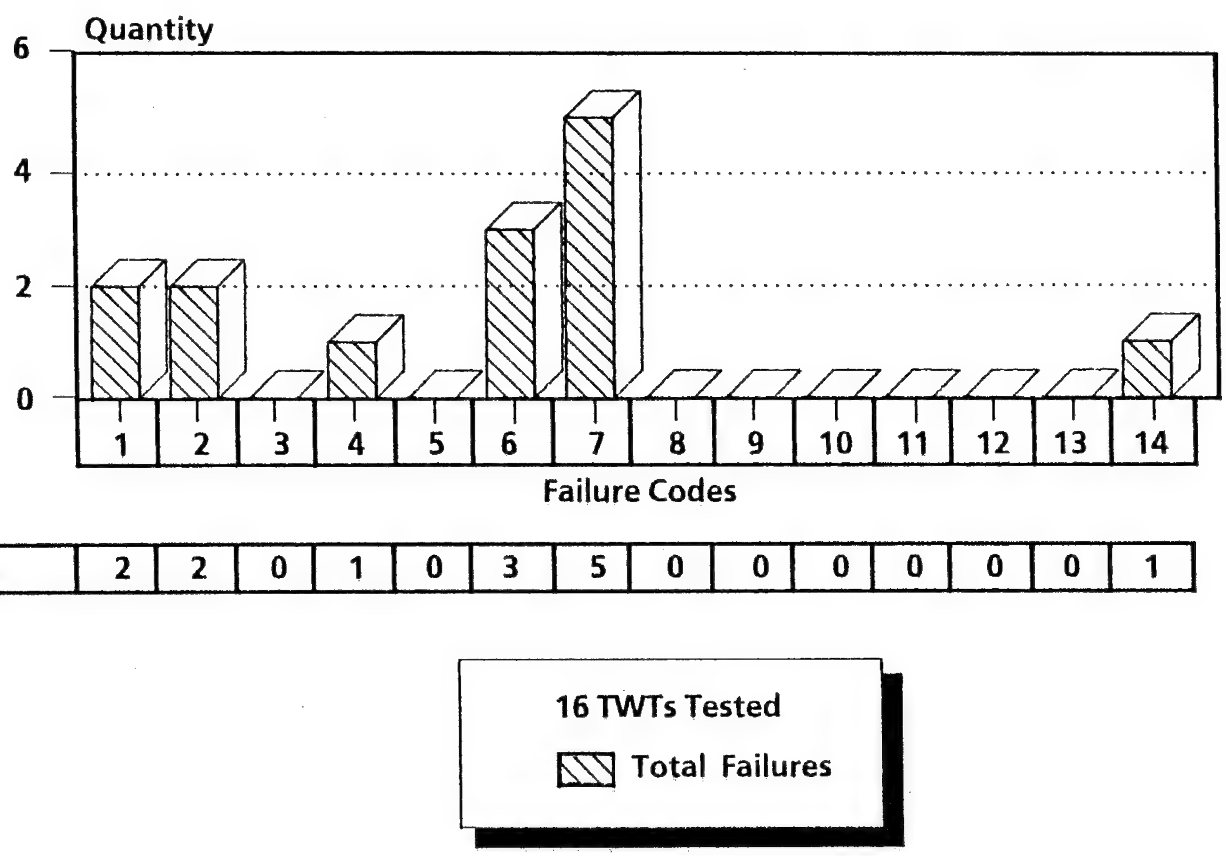
Total Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(1985 Date Code)

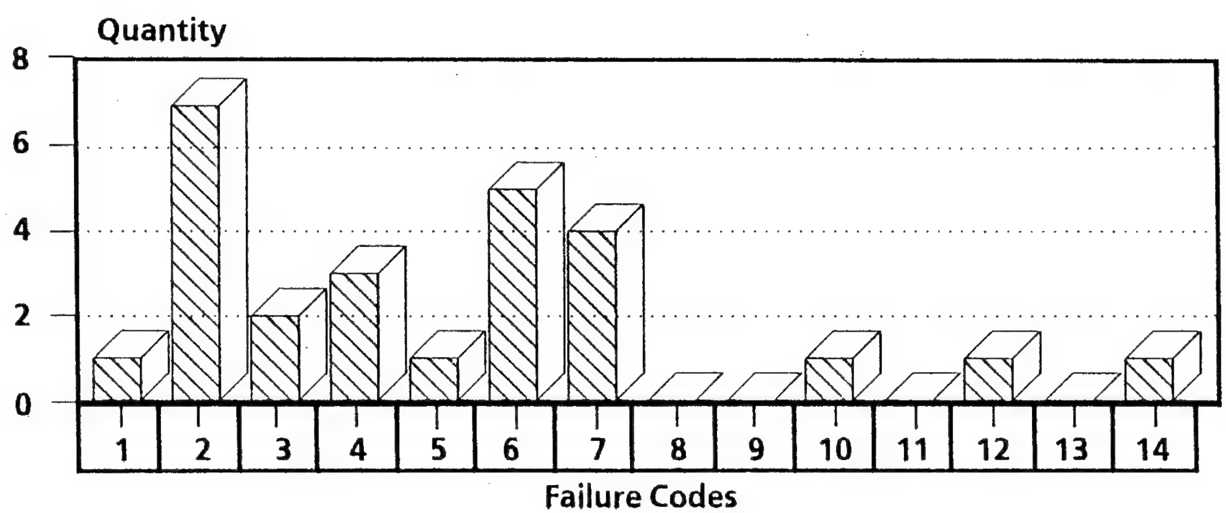


Total Failures	2	2	0	1	0	3	5	0	0	0	0	0	0	1

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(1986 Date Code)



	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Total Failures	1	7	2	3	1	5	4	0	0	1	0	1	0	1

30 TWTs Tested

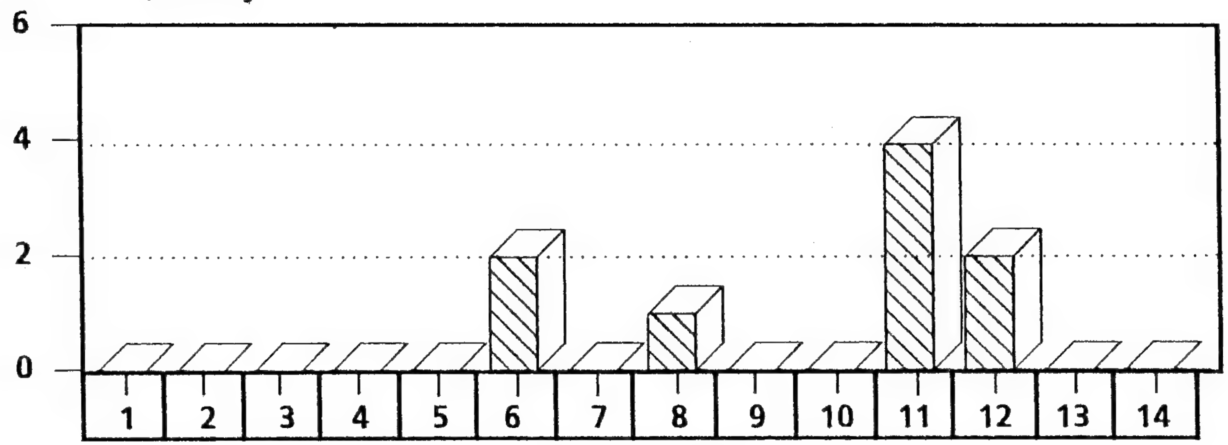
Total Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton (Used)
(1987 Date Code)



Total Failures	0	0	0	0	0	2	0	1	0	0	4	2	0	0

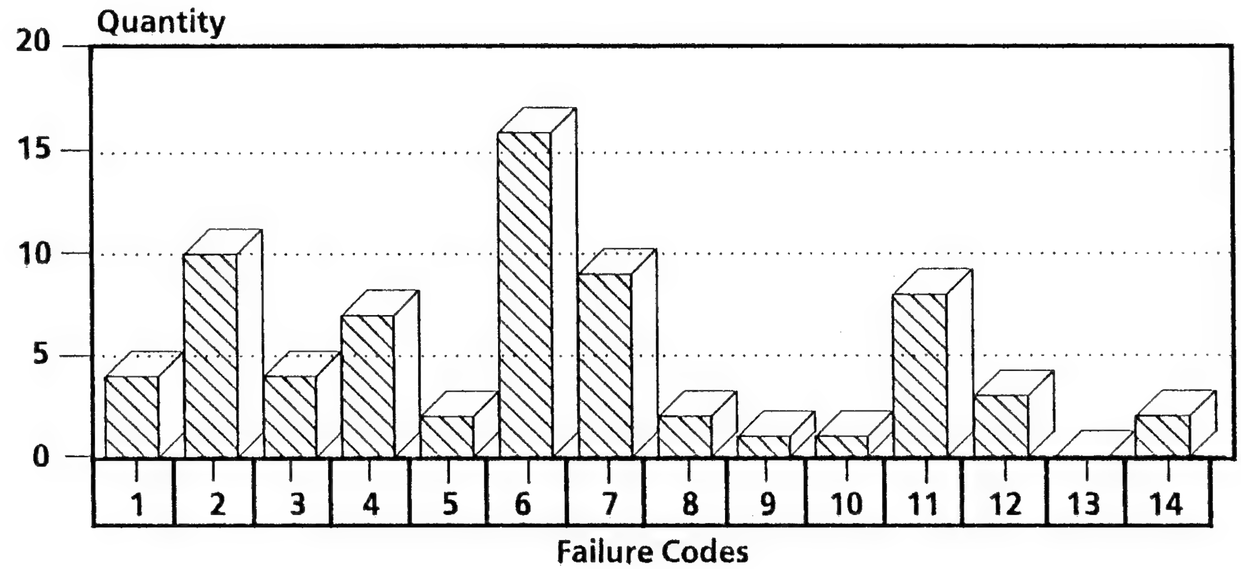
4 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 3 Litton by Failure Codes



Total Failures	4	10	4	7	2	16	9	2	1	1	8	3	0	2

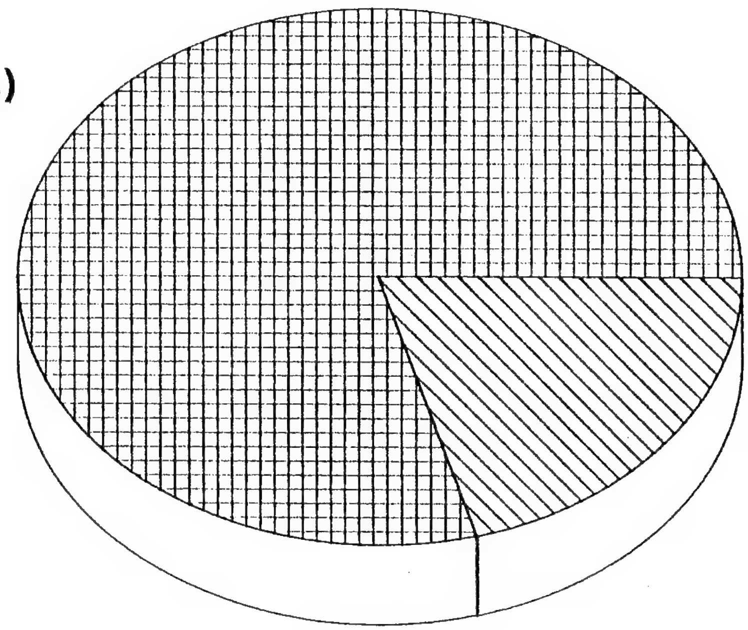
64 TWTs Tested

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)

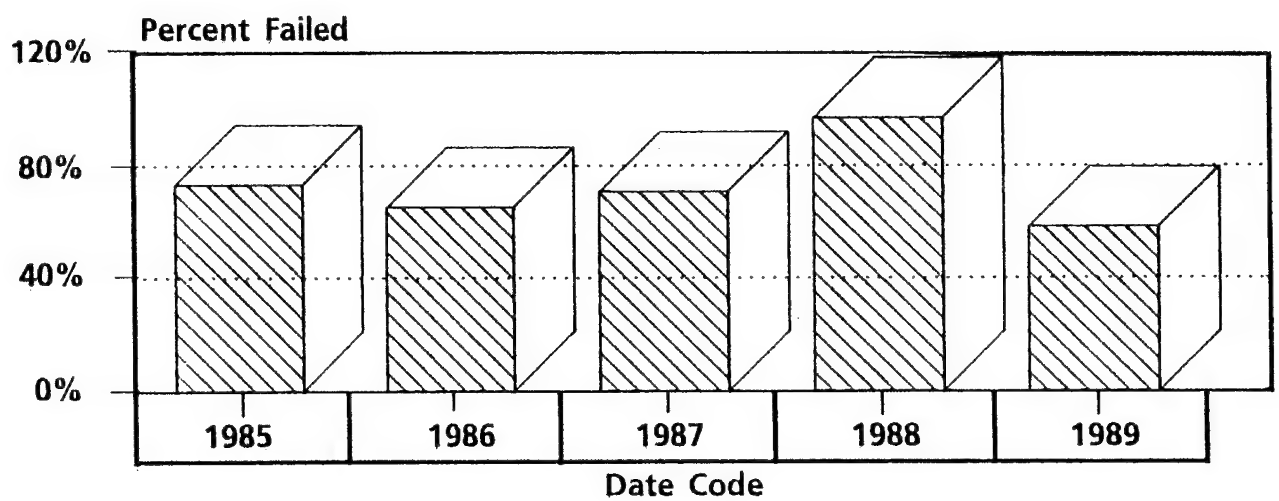


150 TWTs Tested

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(Failure Code 1)



Percent Failed/Year	73.3%	65.3%	70.8%	97.1%	58.3%

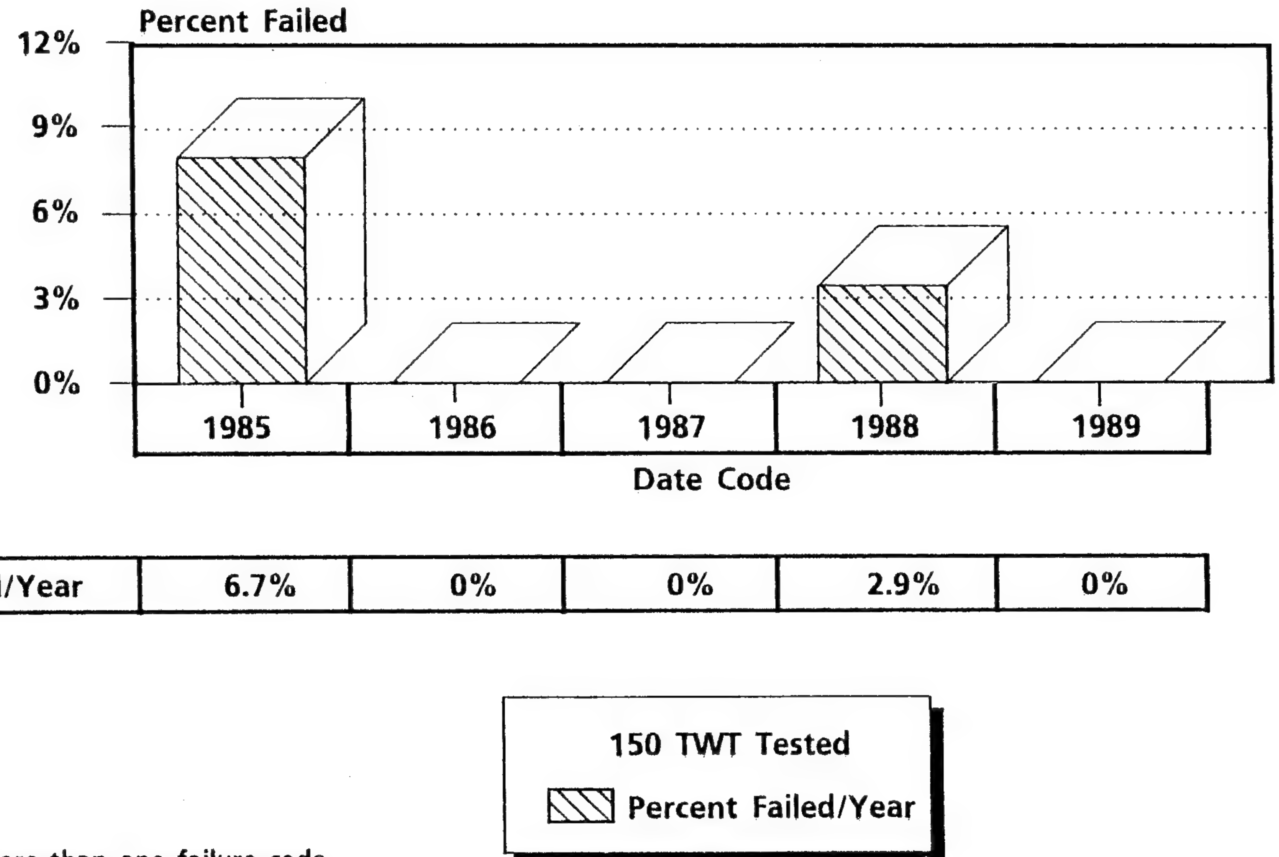
150 TWT Tested

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(Failure Code 2)

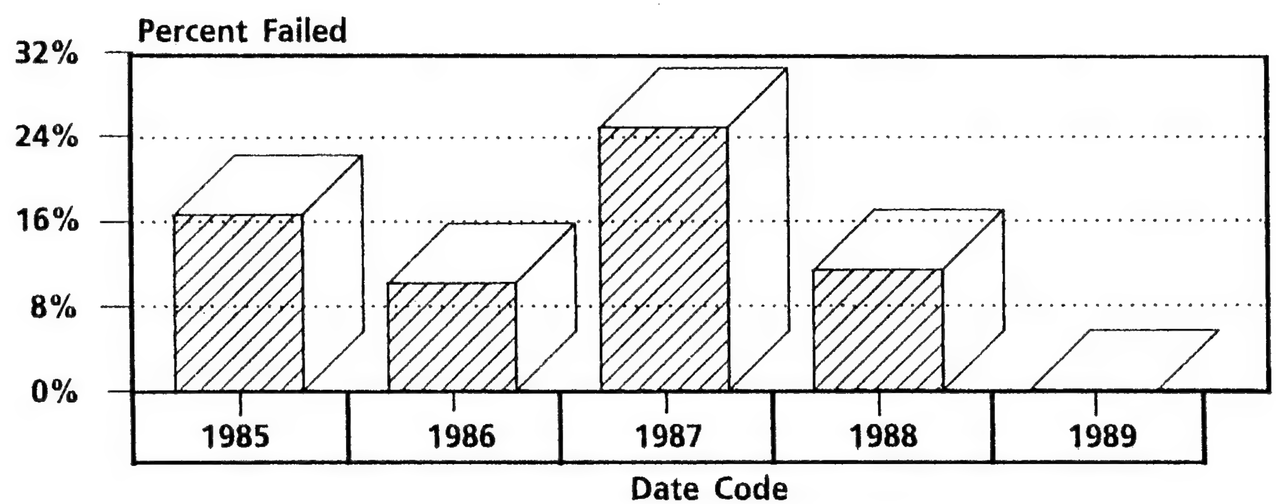


Percent Failed/Year	6.7%	0%	0%	2.9%	0%

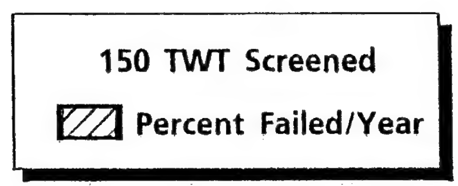
* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(Failure Code 3)



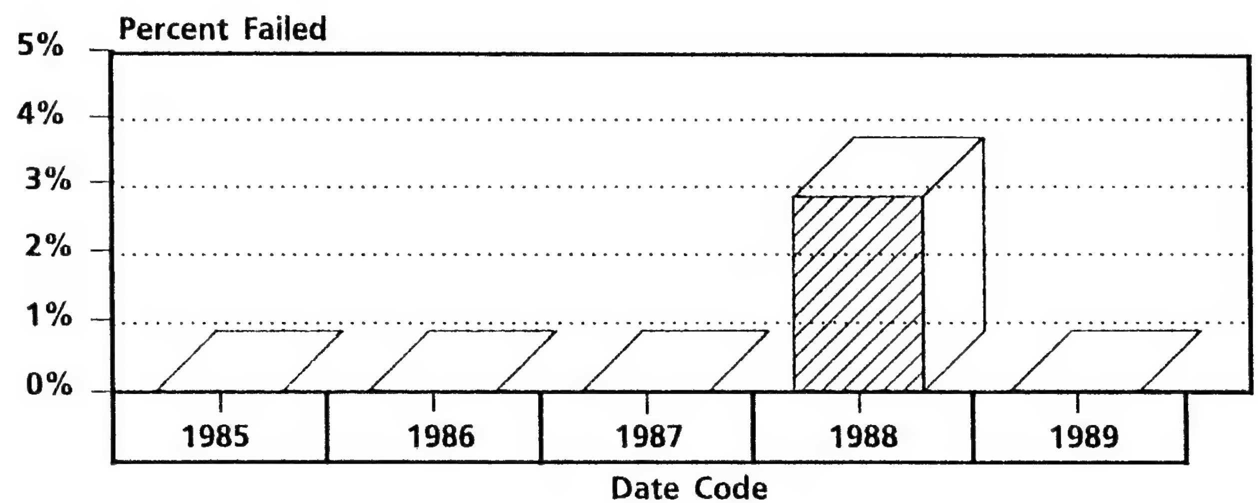
Percent Failed/Year	16.7%	10.2%	25%	11.4%	0%



* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(Failure Code 4)



Percent Failed/Year	0%	0%	0%	2.9%	0%

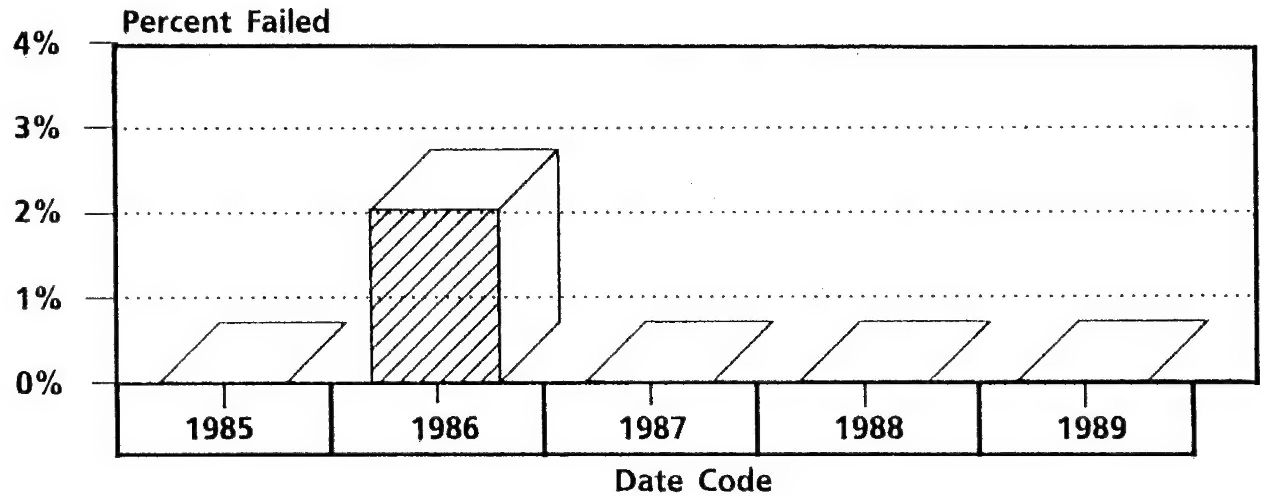
150 TWT Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(Failure Code 5)



Percent Failed/Year	0%	2%	0%	0%	0%

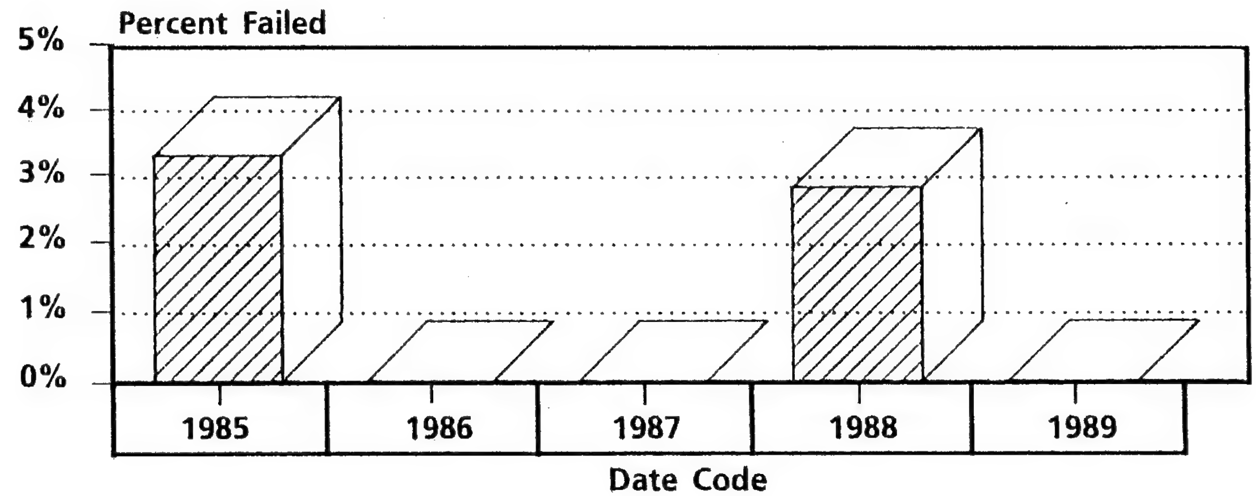
150 TWT Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(Failure Code 6)



Percent Failed/Year	3.3%	0%	0%	2.9%	0%

150 TWT Screened

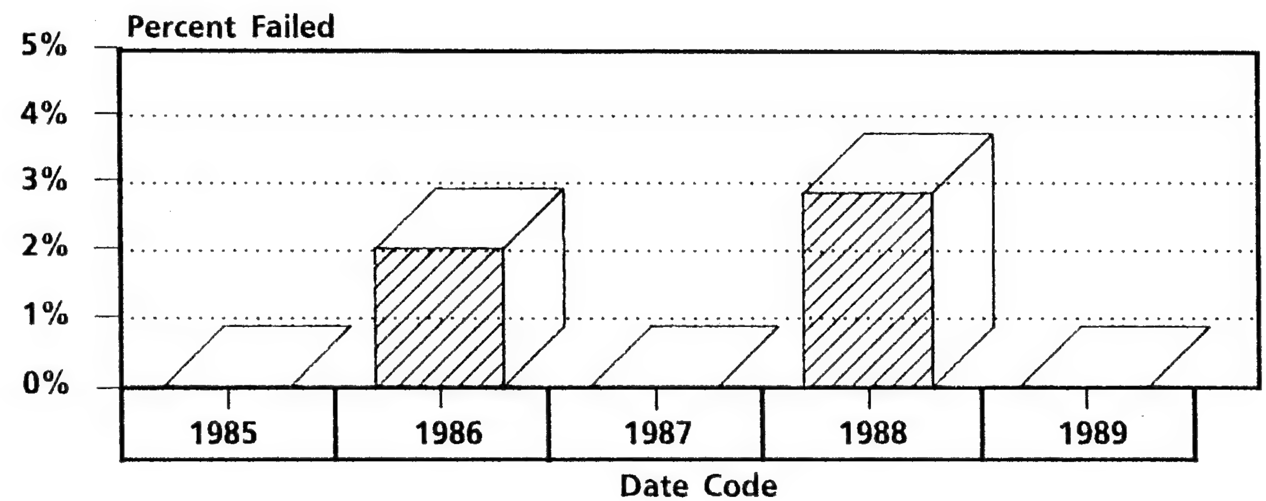
Percent Failed/Year

* Each TWT may have more than one failure code

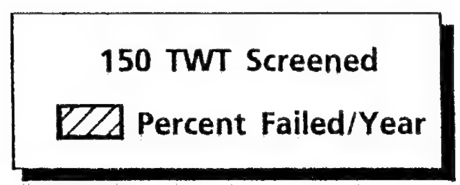
Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(Failure Code 7)



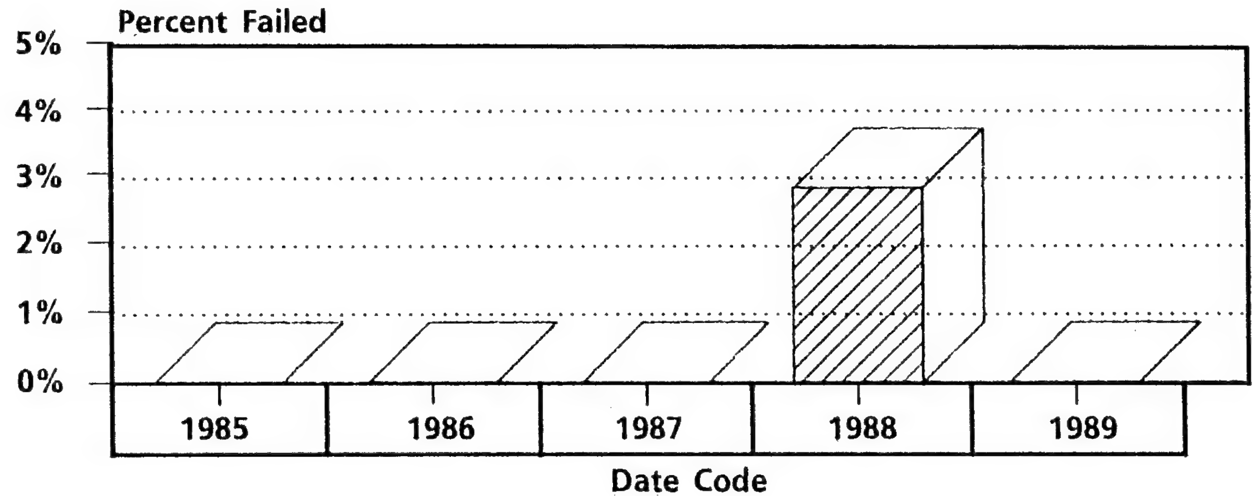
Percent Failed/Year	0%	2.0%	0%	2.9%	0%



* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(Failure Code 8)



Percent Failed/Year	0%	0%	0%	2.9%	0%

150 TWT Screened

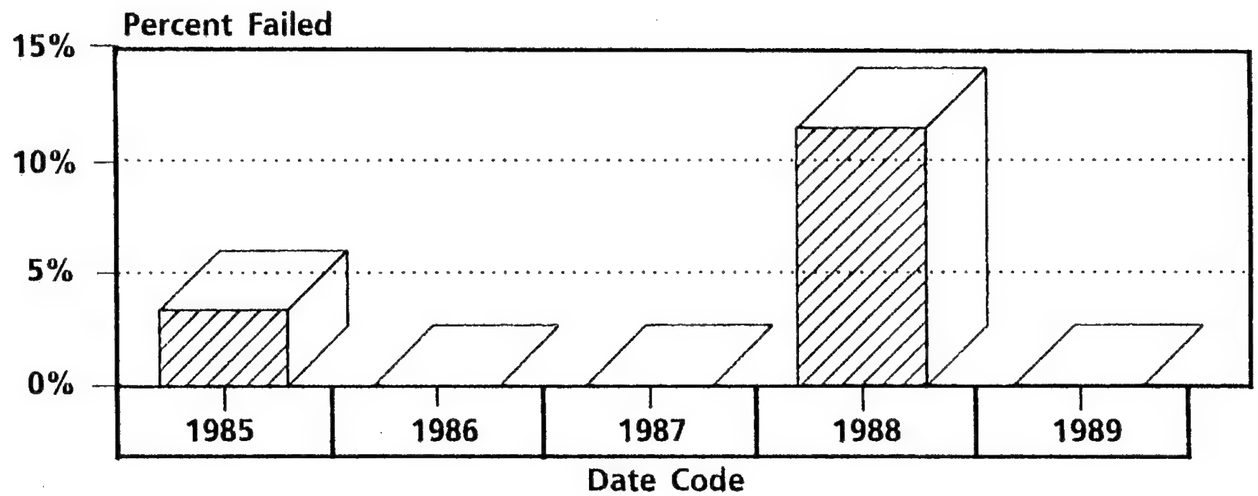
Percent Failed/Year

* Each TWT may have more than one failure code

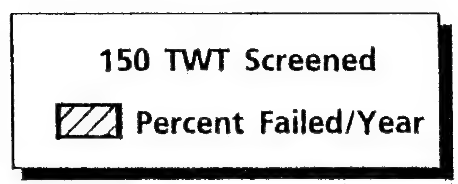
Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(Failure Code 9)



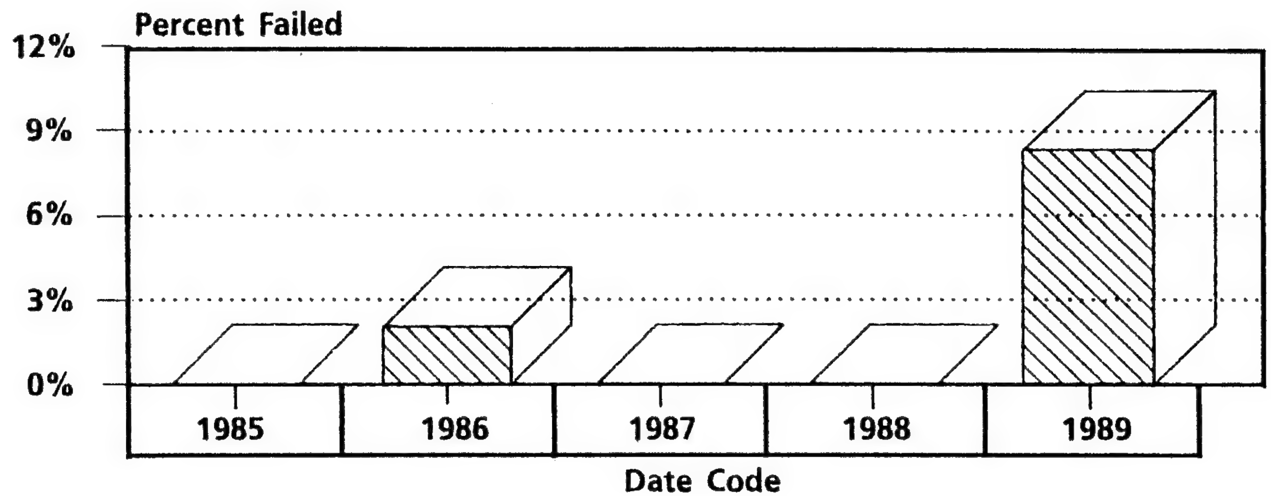
	1985	1986	1987	1988	1989
Percent Failed/Year	3.3%	0%	0%	11.4%	0%



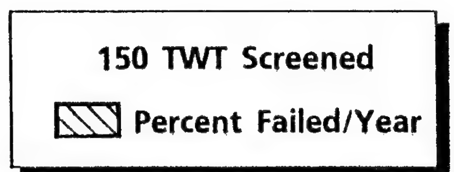
* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(Failure Code 11)



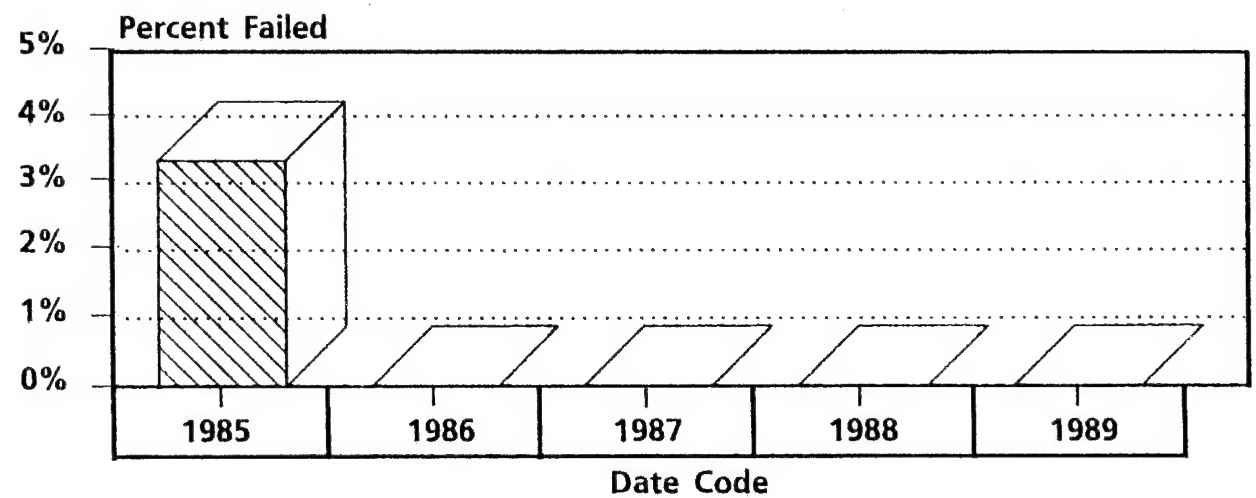
Percent Failed/Year	0%	2%	0%	0%	8.3%



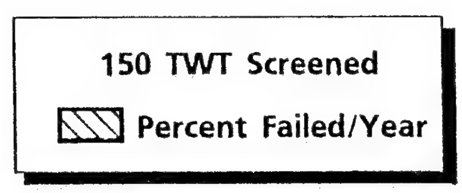
* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(Failure Code 13)



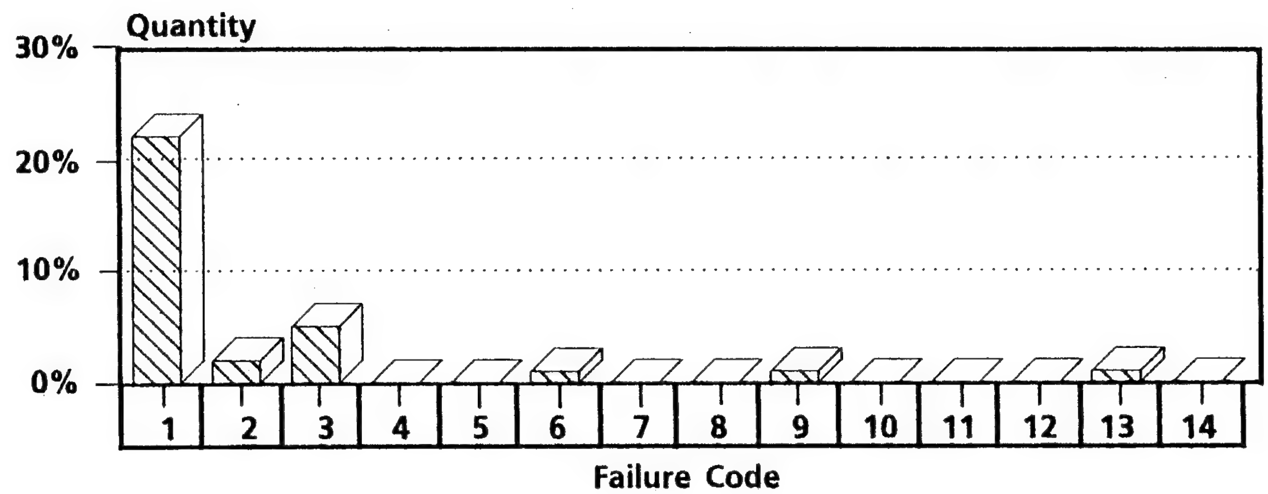
Percent Failed/Year	3.3%	0%	0%	0%	0%



* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(1985 Date Code)

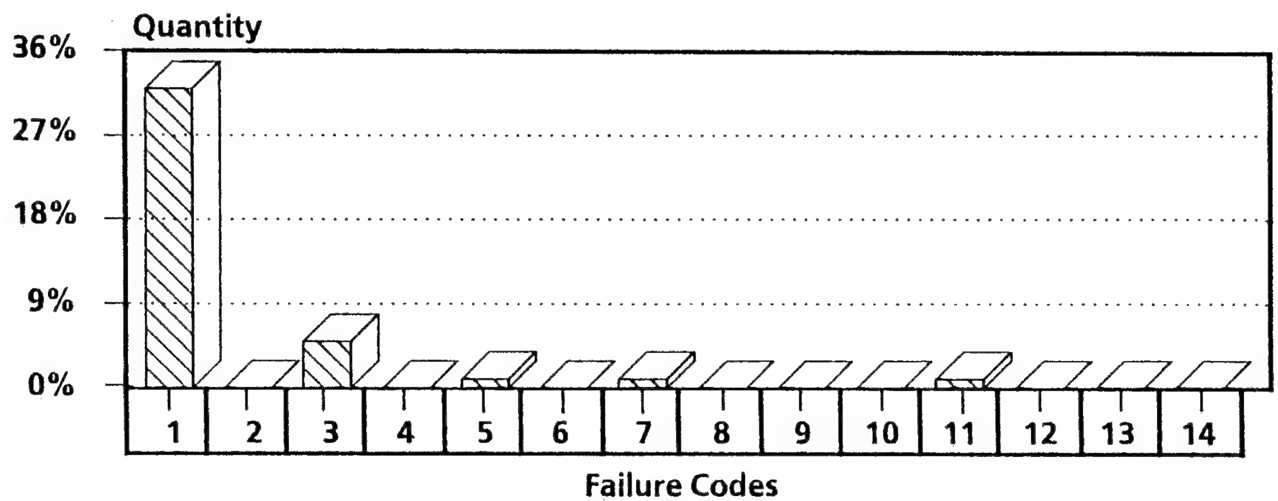


Total Failures	22	2	5	0	0	1	0	0	1	0	0	0	1	0

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(1986 Date Code)



Total Failures	32	0	5	0	1	0	1	0	0	0	1	0	0	0

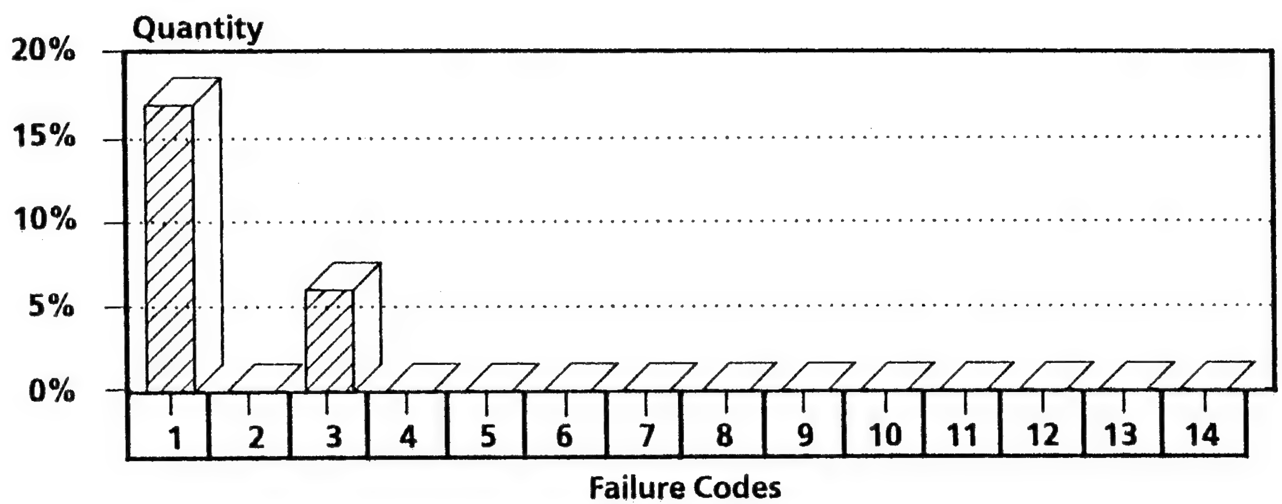
30 TWTs Screened

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(1987 Date Code)



Total Failures	17	0	6	0	0	0	0	0	0	0	0	0	0	0

24 TWTs Screened

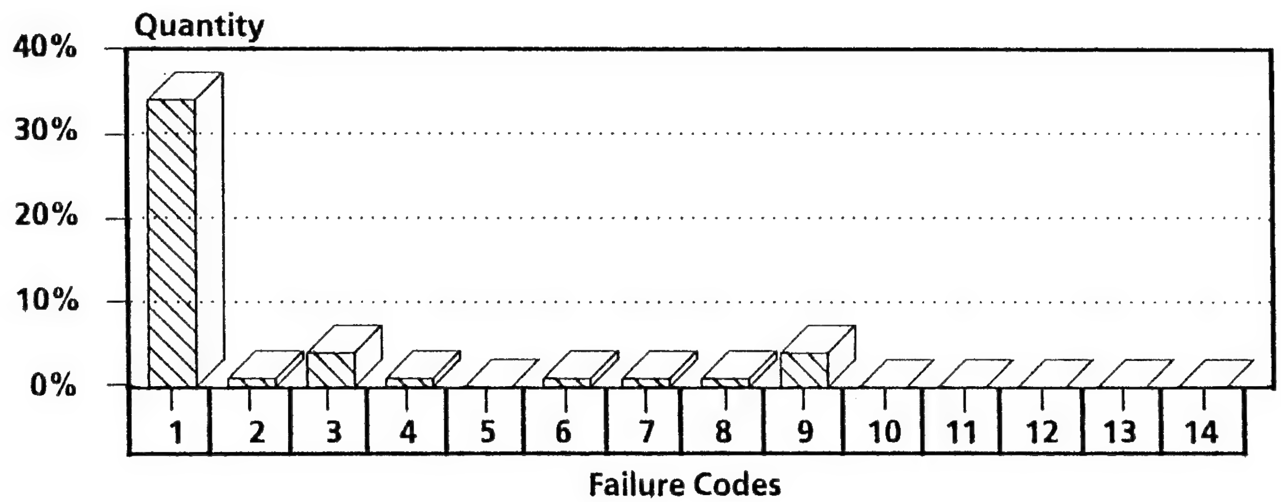
Total Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(1988 Date Code)



Total Failures	34	1	4	1	0	1	1	1	4	0	0	0	0	0

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
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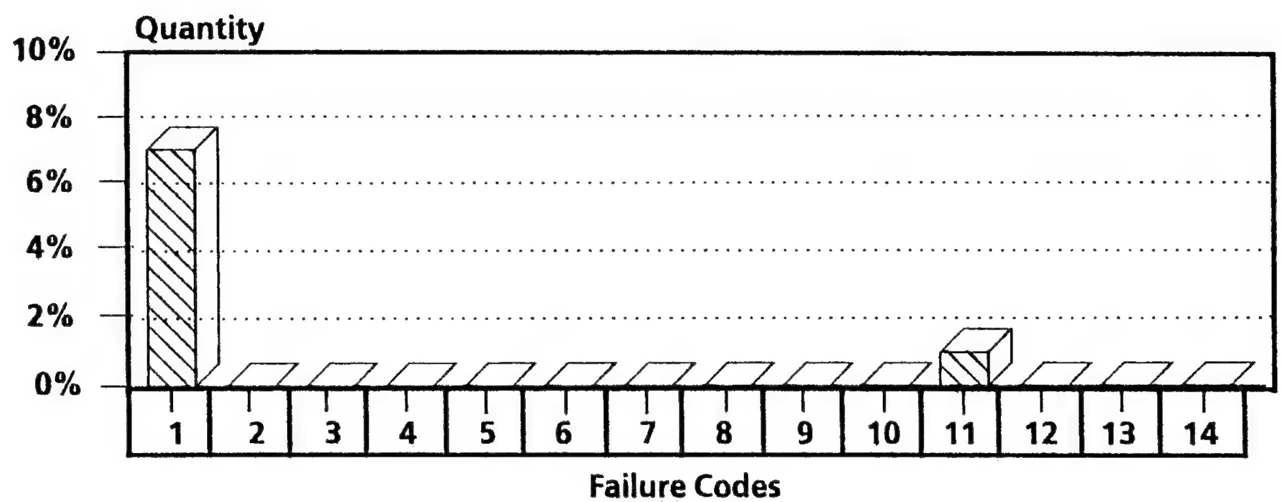
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New)
(1989 Date Code)



Total Failures	7	0	0	0	0	0	0	0	0	0	1	0	0	0

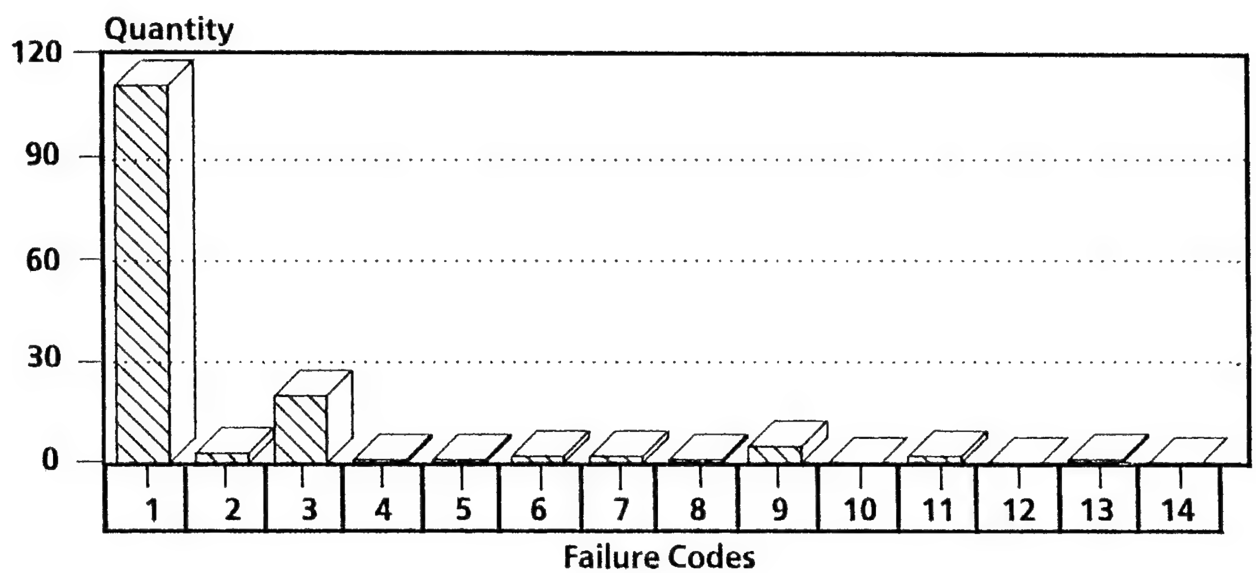
12 TWTs Screened

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 4 Litton (New) By Failure Codes



Total Failures	112	3	20	1	1	2	2	1	5	0	2	0	1	0

150 TWTs Tested

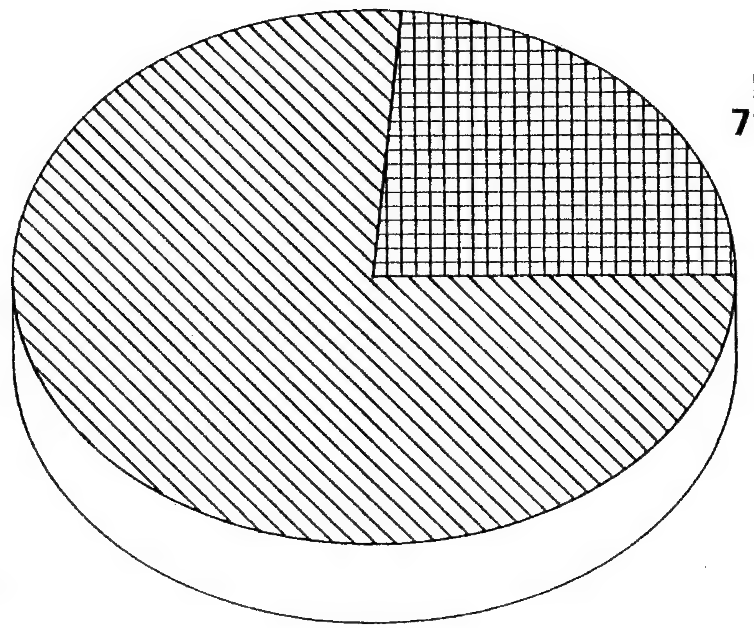
Total Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

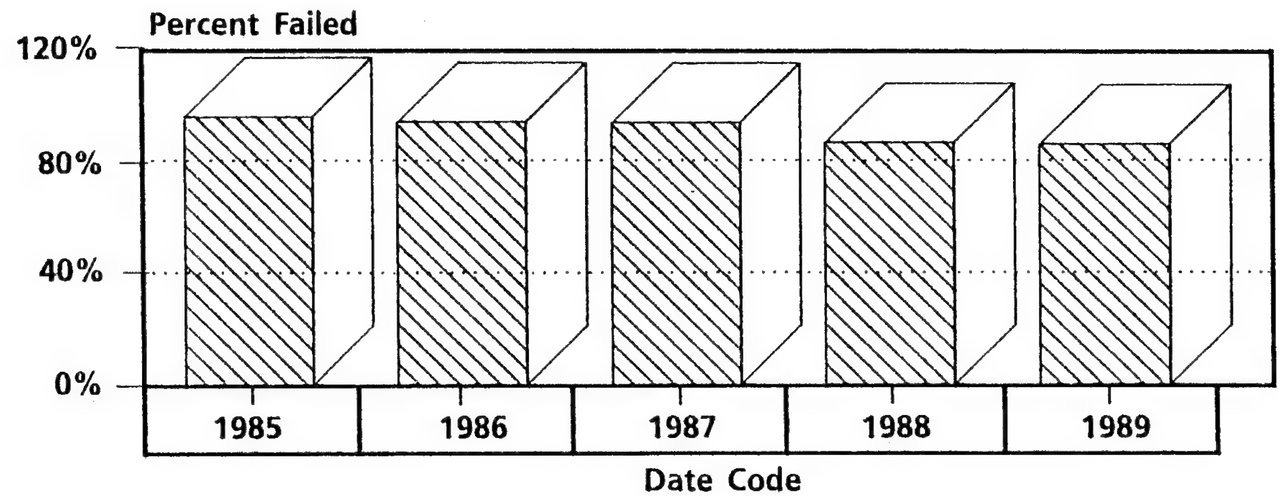
Screening Summary: Band 5 Litton (New)



300 TWTs Tested

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(Failure Code 1)



Percent Failed/Year	95.7%	93.8%	93.5%	86.3%	85.7%

300 TWT Screened

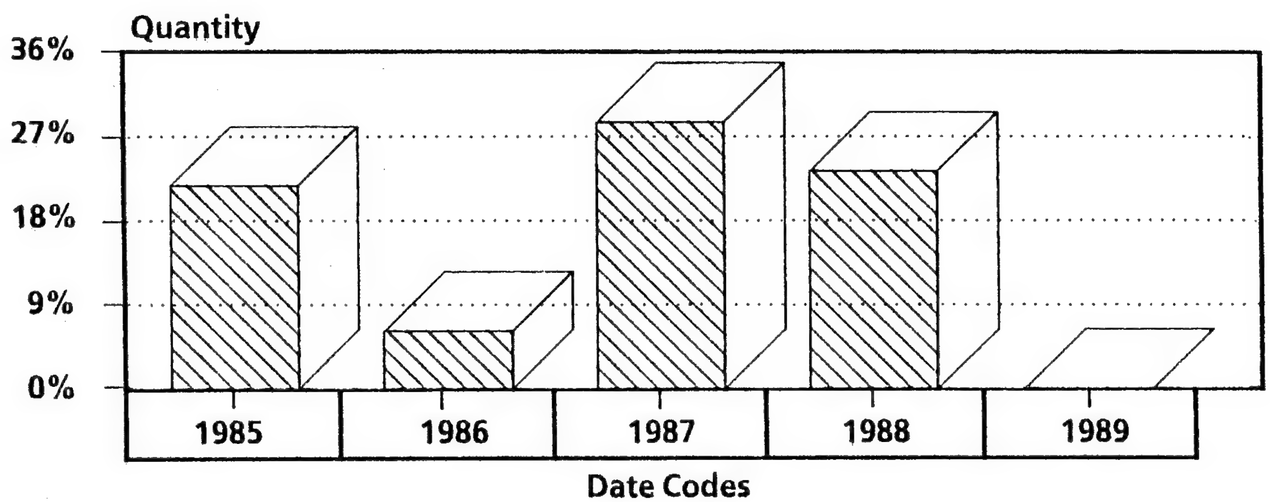
Percent Failed/Year

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(Failure Code 2)

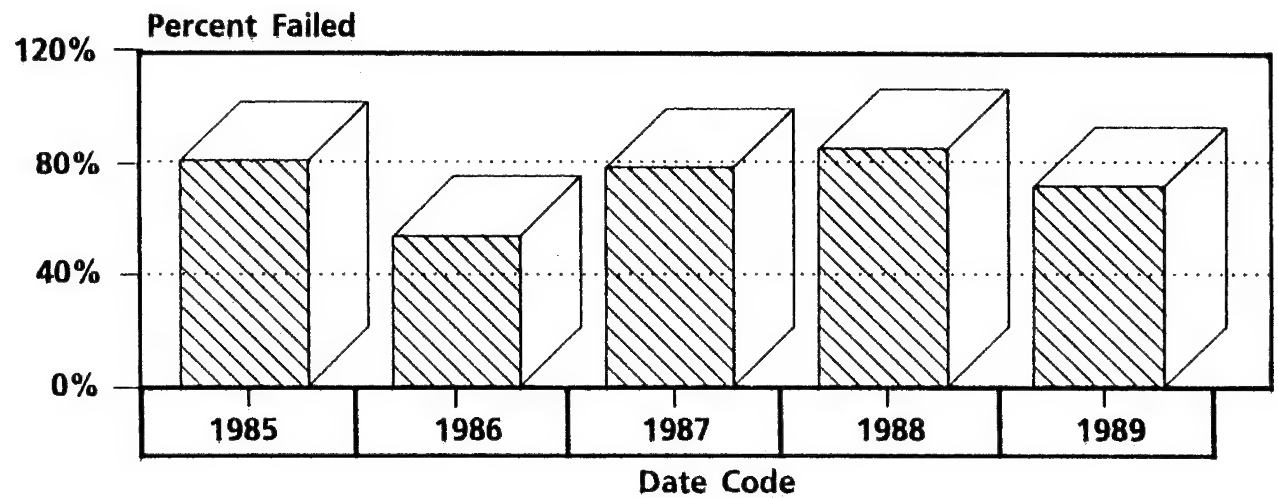


Percent Failed/Year	21.7%	6.2%	28.6%	23.3%	0%

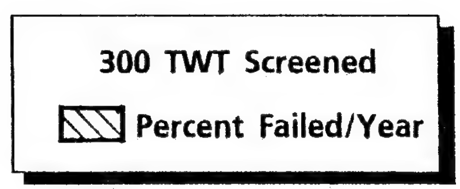
* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(Failure Code 3)



Percent Failed/Year	80.4%	53.6%	77.9%	84.9%	71.4%

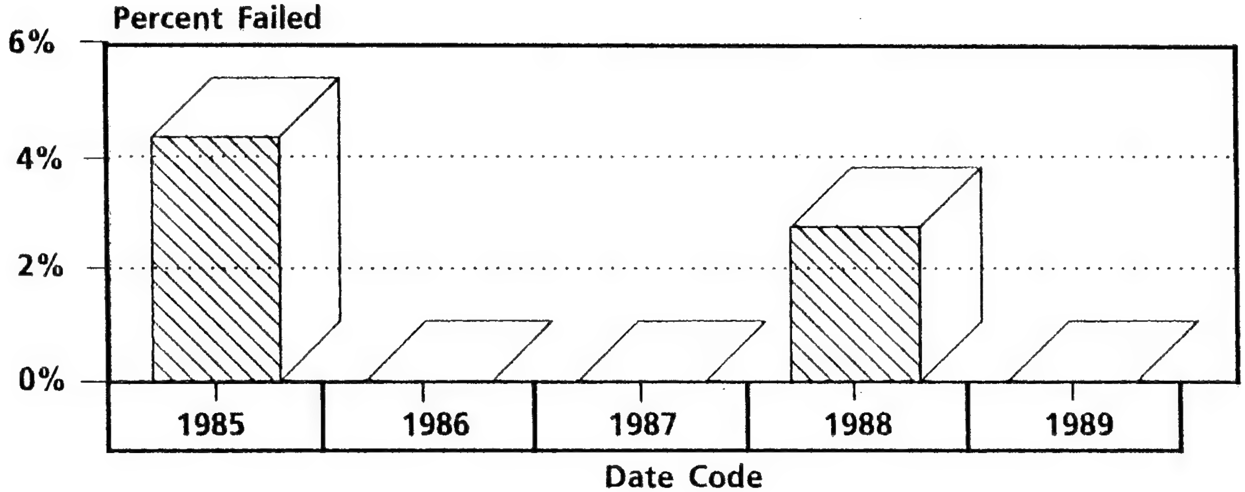


* Each TWT may have more than one failure code

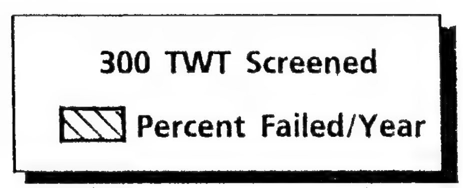
Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(Failure Code 4)



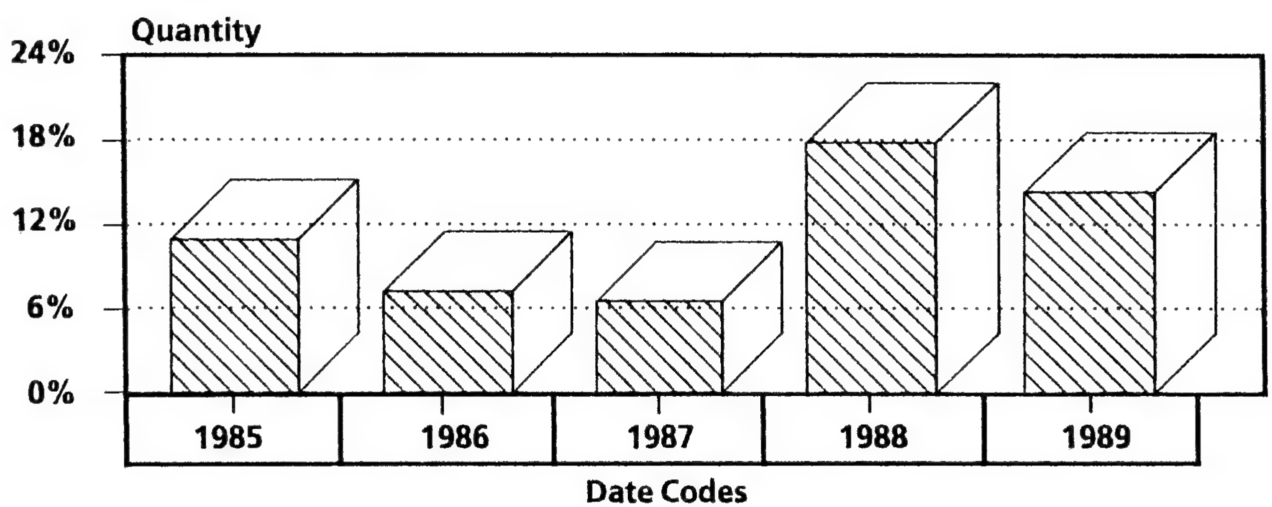
Percent Failed/Year	4.3%	0%	0%	2.7%	0%



* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(Failure Code 5)



	1985	1986	1987	1988	1989
Percent Failed/Year	10.9%	7.2%	6.5%	17.8%	14.3%

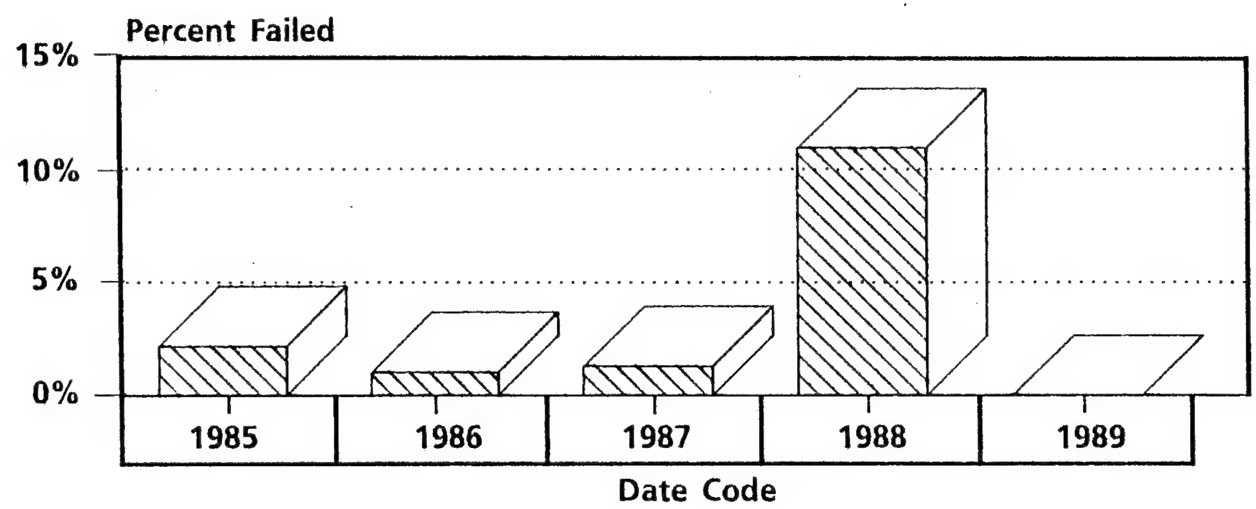
300 TWT Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(Failure Code 6)



Percent Failed/Year	2.2%	1%	1.3%	11%	0%

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
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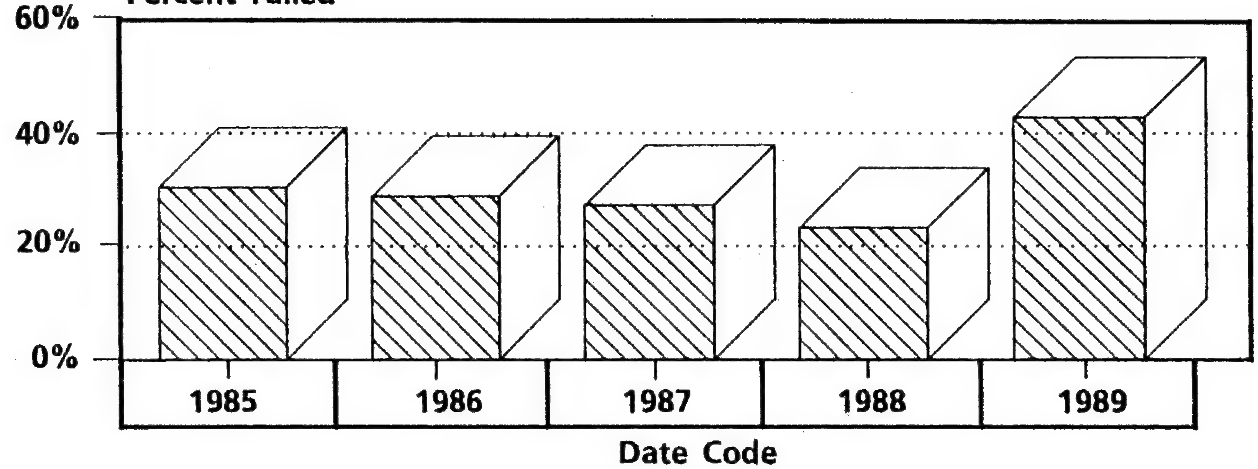
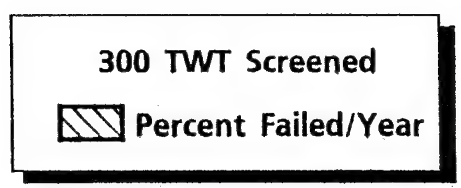
AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(Failure Code 7)



Percent Failed/Year	30.4%	28.9%	27.3%	23.3%	42.9%

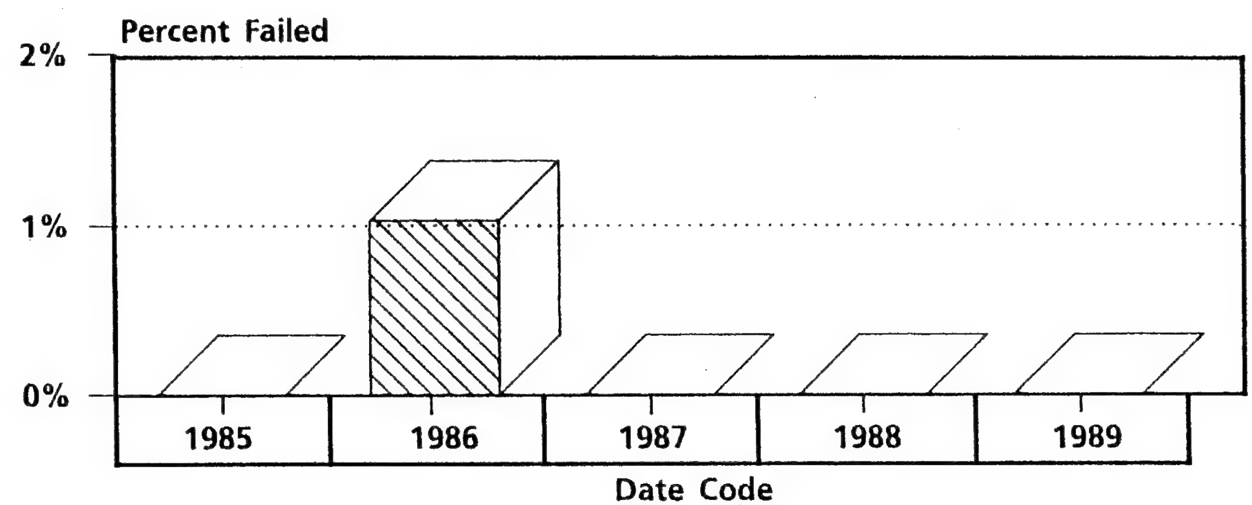


* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(Failure Code 8)



Percent Failed/Year	0%	1%	0%	0%	0%

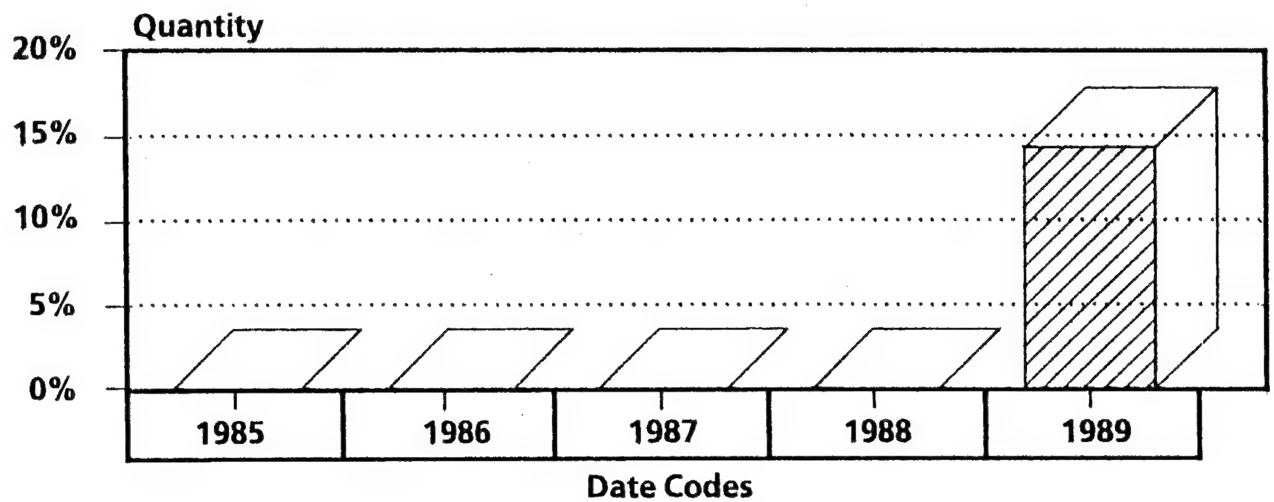
300 TWT Screened

Percent Failed/Year

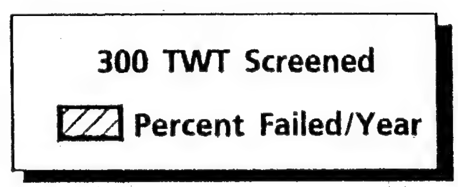
* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(Failure Code 9)



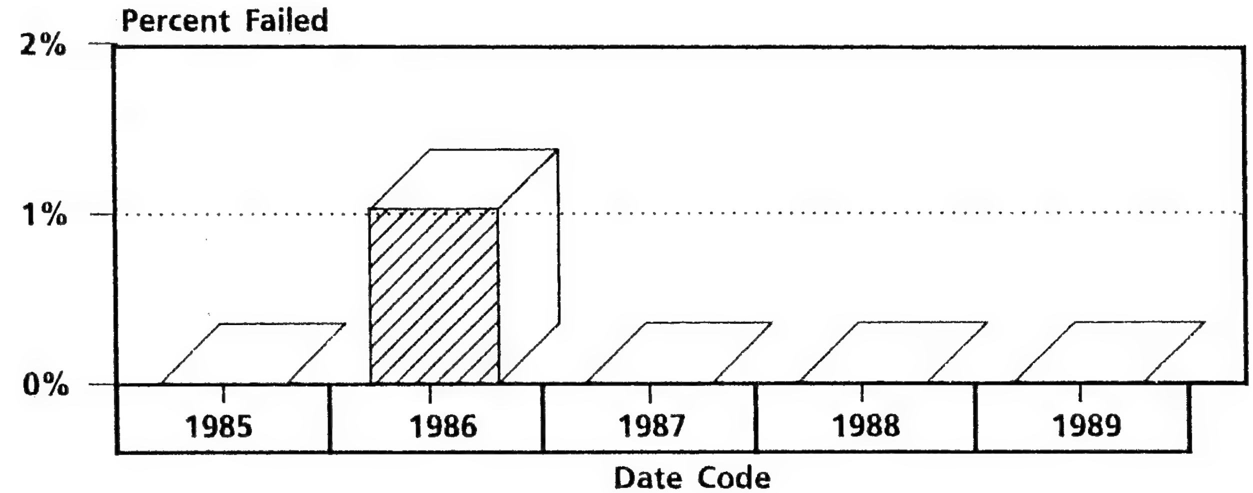
Percent Failed/Year	0%	0%	0%	0%	14.3%



* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(Failure Code 11)



Percent Failed/Year	0%	1%	0%	0%	0%

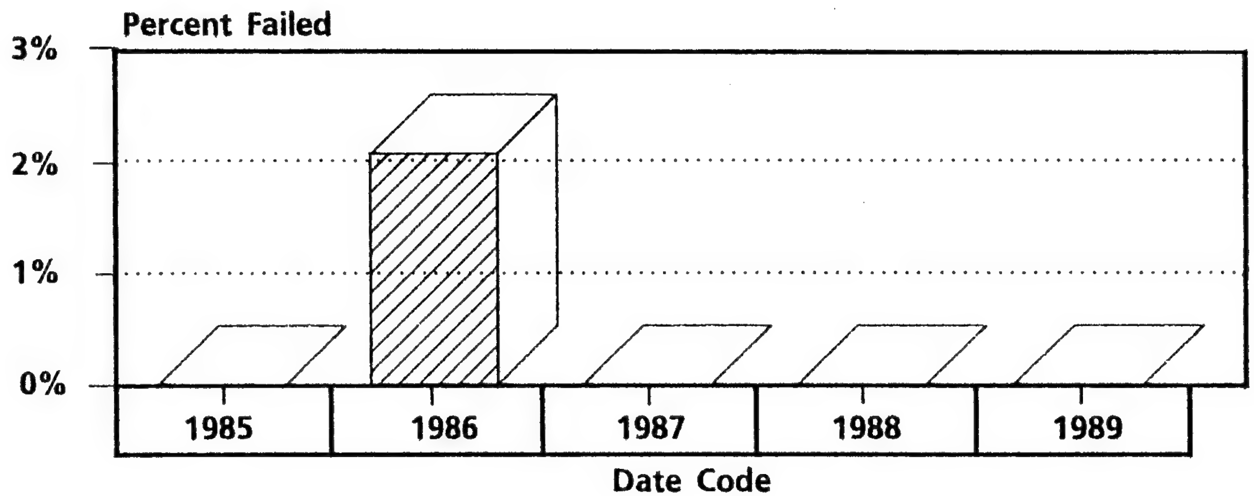
300 TWT Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(Failure Code 14)



Percent Failed/Year	0%	2.1%	0%	0%	0%

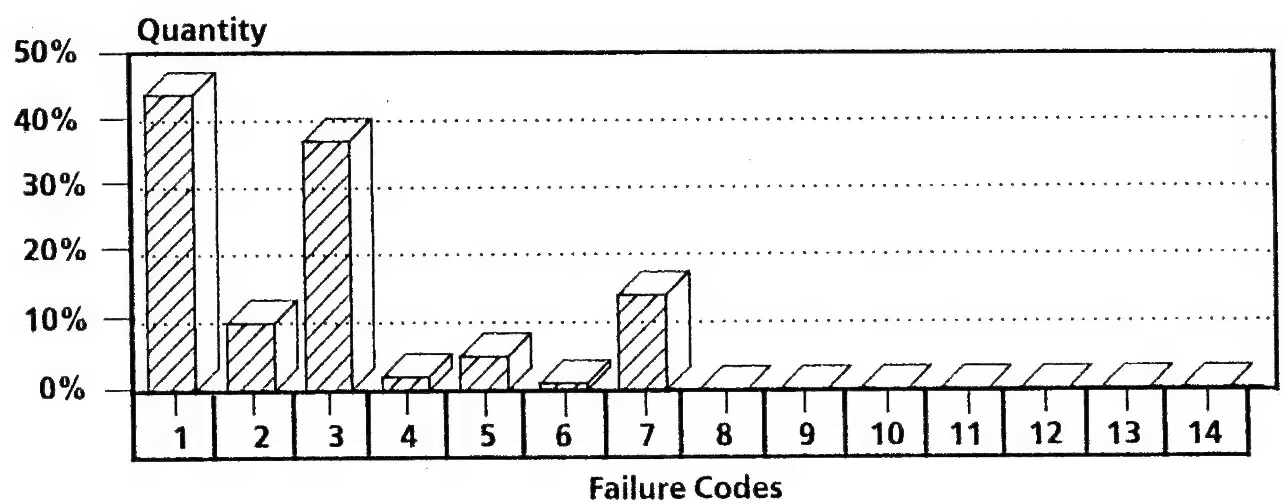
300 TWT Screened

Percent Failed/Year

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(1985 Date Code)



Total Failures	44	10	37	2	5	1	14	0	0	0	0	0	0	0

46 TWTs Screened

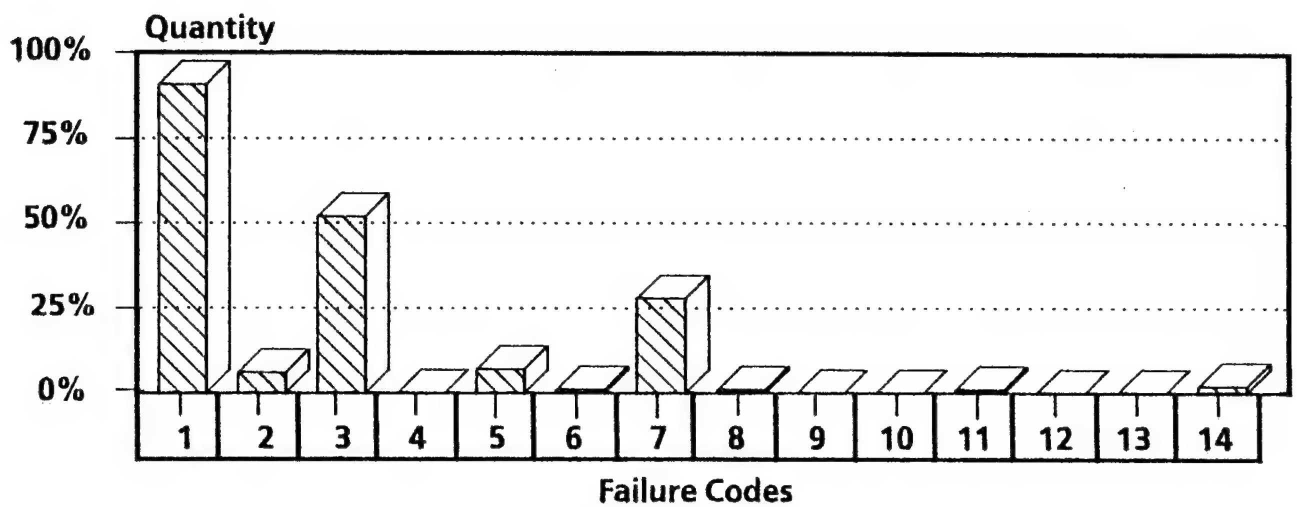
Total Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(1986 Date Code)



Total Failures	91	6	52	0	7	1	28	1	0	0	1	0	0	2

97 TWTs Screened

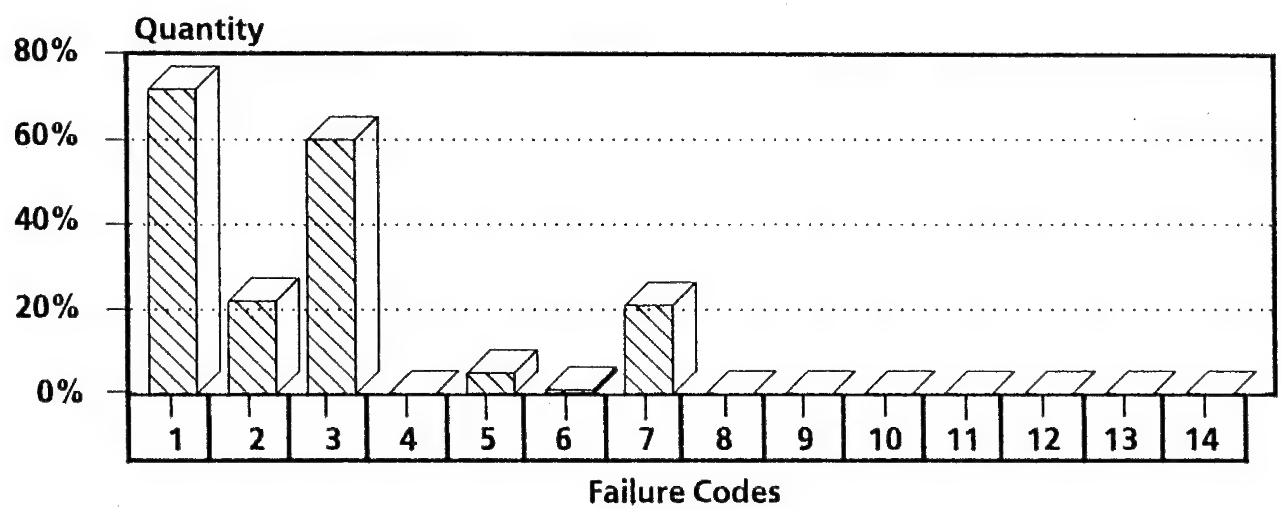
Total Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(1987 Date Code)



Total Failures	72	22	60	0	5	1	21	0	0	0	0	0	0	0

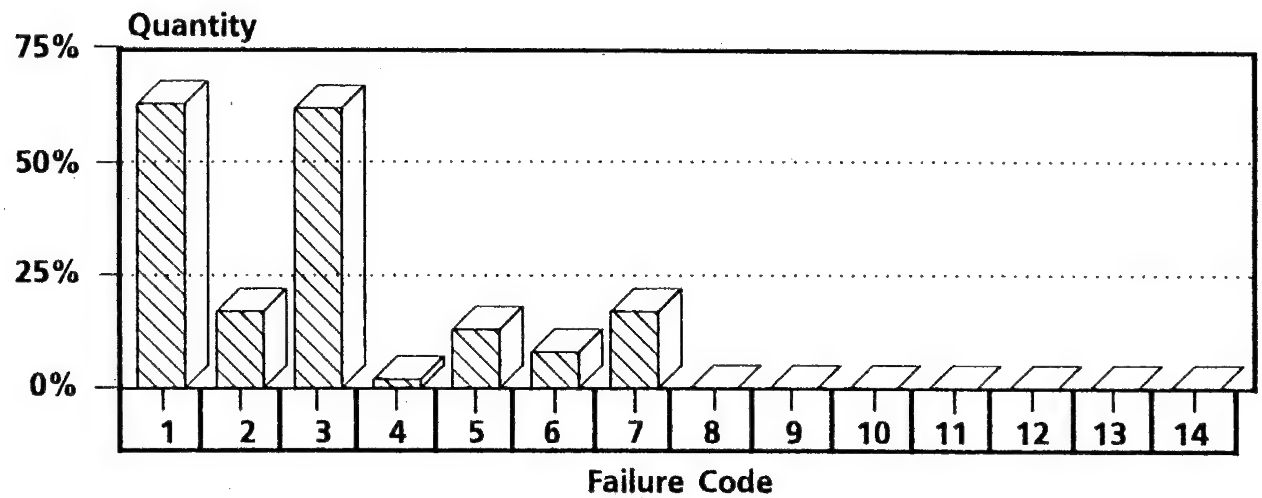
77 TWTs Screened

Total Failures

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(1988 Date Code)

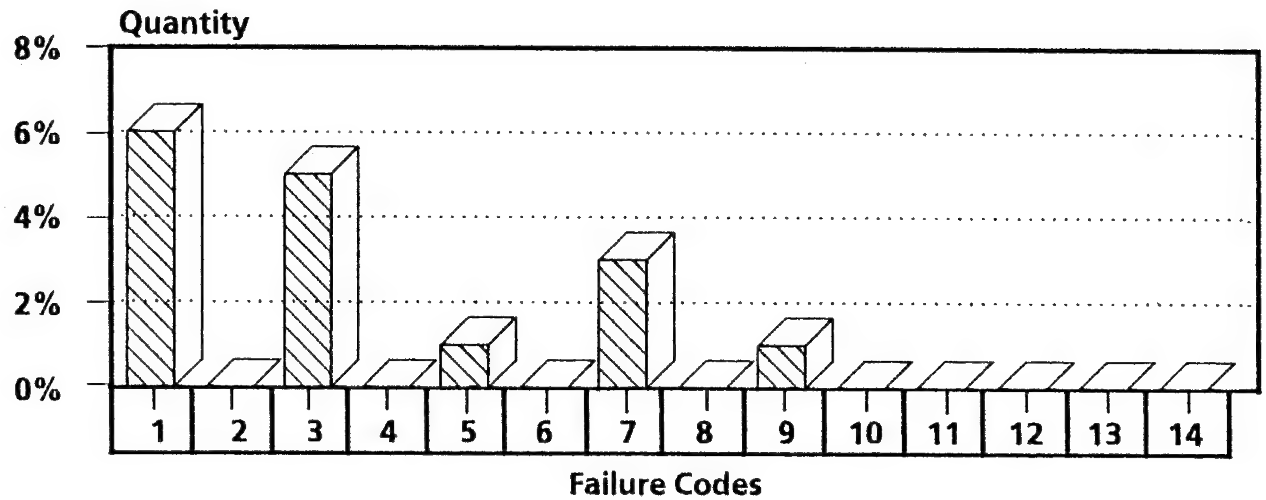


Total Failures	63	17	62	2	13	8	17	0	0	0	0	0	0	0

* Each TWT may have more than one failure code

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New)
(1989 Date Code)



Total Failures	6	0	5	0	1	0	3	0	1	0	0	0	0	0

7 TWTs Screened

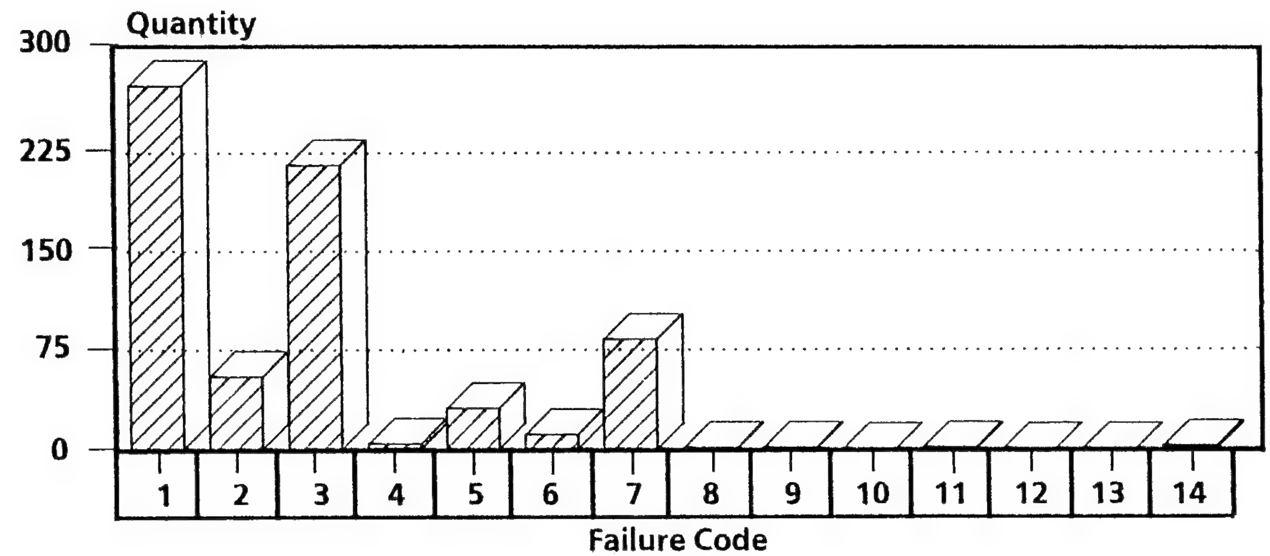
Total Failures

* Each TWT may have more than one failure code

Westinghouse Electric Corporation
Regional Service Center
Warner Robins, Georgia

AN/ALQ-131 DRIVER TWTs

Screening Summary: Band 5 Litton (New) by Failure Codes



	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Total Failures	276	55	216	4	31	11	83	1	1	0	1	0	0	2

* Each TWT may have more than one failure code

AN/ALQ-131 BLOCK I Band 3 VARIAN Output TWTs
(TWTs with Perveance Problems)

Part Number .... 583R679H01 | Vendor .... VARIAN
Stock Number .... 5960-01-040-4440EW | Band 3
New TWT .... No | Block I

Item No	Serial Number	Date Code	Ib2 Actual (mA)	Ib2 Label (mA)	Eg Actual (V)	Eg Label (V)	Delta Eg (V)	Ik Actual (mA)	Pass/ Fail	*TWT Status
1.	0287	8150	591	588	167	133	34	630	FAIL	AA
2.	45006	8039	577	580	162	144	18	632	FAIL	FF
3.	0288	9999	569	569	158	145	13	620	FAIL	AA
4.	0341	8408	583	577	147	136	11	630	FAIL	FF
5.	0386	8421	555	585	170	145	25	606	FAIL	FF
6.	0367	8413	588	588	162	130	32	630	FAIL	AA
7.	0366	8413	561	578	170	150	20	610	FAIL	AA
8.	0118	8150	554	552	164	150	14	615	FAIL	FF
9.	0454	8443	565	563	152	133	19	630	FAIL	AA
10.	0426	8434	577	582	158	143	15	620	FAIL	AA
11.	0247	9999	562	566	170	136	34	626	FAIL	AA
12.	0331	8408	568	590	170	147	23	605	FAIL	FF
13.	48070	8121	536	575	170	148	22	570	FAIL	FF
14.	0285	9999	546	546	168	132	36	600	FAIL	AA
15.	45059	8352	559	572	169	141	28	630	FAIL	AA
16.	0373	8417	548	582	170	158	12	587	FAIL	FF
17.	0404	8426	573	575	140	117	23	630	FAIL	AA
18.	45011	8044	577	570	170	146	24	613	FAIL	AA
19.	0228	9999	541	572	170	160	10	584	FAIL	FF
20.	0466	8447	552	558	165	144	21	630	FAIL	AA

* Failure codes & review board codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 VARIAN Output TWTs (TWTs with Perveance Problems)

Part Number	583R679H01	Vendor	VARIAN
Stock Number	5960-01-040-4440EW	Band	3
New TWT	No	Block	I

Item No	Serial Number	Date Code	Ib2 Actual (mA)	Ib2 Label (mA)	Eg Actual (V)	Eg Label (V)	Delta Eg (V)	Ik Actual (mA)	Pass/ Fail	*TWT Status
21.	0280	9999	559	560	158	140	18	630	FAIL	FF
22.	48028	8021	601	595	158	142	16	630	FAIL	AA
23.	0399	8426	589	589	170	130	40	630	FAIL	FF
24.	0268	9999	578	573	169	147	22	620	FAIL	FF
25.	0439	8439	578	586	165	143	22	630	FAIL	AA
26.	45048	9999	577	568	167	138	29	630	FAIL	FF
27.	0383	8421	597	598	158	148	10	630	FAIL	AA
28.	0275	9999	553	589	170	152	18	600	FAIL	FF
29.	0430	8439	568	570	153	123	30	620	FAIL	AA
30.	0238	9999	560	542	180	140	40	600	FAIL	FF
31.	0133	8243	543	545	182	125	57	600	FAIL	FF
32.	0220	9999	569	571	180	151	29	620	FAIL	FF
33.	0313	8404	577	573	179	127	52	620	FAIL	FF
34.	48071	8121	575	574	162	144	18	620	FAIL	FF
35.	48017	8030	570	570	167	136	31	626	FAIL	FF
36.	0494	8504	532	552	166	142	24	621	FAIL	AA
37.	45047	9999	47	575	147	147	0		FAIL	FF
38.	0401	8426	572	592	167	157	10	640	FAIL	AA
39.	0402	8426	548	550	178	128	50	600	FAIL	FF
40.	48102	8130	559	554	183	146	37	620	FAIL	FF

* Failure codes & review board codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 VARIAN Output TWTs
(TWTs with Perveance Problems)

Part Number	583R679H01	Vendor	VARIAN
Stock Number	5960-01-040-4440EW	Band	3
New TWT	No	Block	I

Item No	Serial Number	Date Code	Ib2 Actual (mA)	Ib2 Label (mA)	Eg Actual (V)	Eg Label (V)	Delta Eg (V)	Ik Actual (mA)	Pass/ Fail	*TWT Status
41.	0146	8252	561	561	156	136	20	605	FAIL	FF
42.	0485	8452	566	592	160	149	11	630	FAIL	FF
43.	0400	8426	565	567	170	141	29	630	FAIL	AA
44.	45017R	8513	552	565	176	142	34	620	FAIL	FF
45.	0129	8243	544	550	177	150	27	605	FAIL	FF
46.	48079	8126	580	575	172	145	27	620	FAIL	FF
47.	48011	8104	584	580	167	121	46	615	FAIL	FF
48.	0297	8352	539	557	180	135	45	620	FAIL	FF
49.	0226	9999	566	550	183	143	40	609	FAIL	FF
50.	0106	8221	565	567	168	140	28	619	FAIL	FF
51.	0414	8434	571	582	166	147	19	620	FAIL	AA
52.	45052	9999	543	545	162	125	37	600	FAIL	AA
53.	0336	8404	557	564	170	148	22	625	FAIL	AA

* Failure codes & review board codes are located on last page of this attachment.

AN/ALQ-131 BLOCK I Band 3 Varian Output TWTs (TWTs with Perveance Problems)

Output TWT Failure Codes

1. *Minor problems (Passed after extended burn-in, etc.)*
2. *Gain*
3. *Fine grain (ripple)*
4. *Power*
5. *HYPOT*
6. *Helix*
7. *Gassy*
8. *Grid leakage*
9. *BWO*
10. *Mechanical*
11. *Perveance (unstable gun)*
12. *Re-optimization Candidate*

TWT Status Codes

1. *AA - Serviceable TWT*
2. *FF - Unserviceable TWT*
3. *ZM - Recommend return to manufacturer*
4. *ZR - Requires retesting*
5. *ZS - Requires system testing*
6. *ZH - Hold pending other test results*
7. *ZZ - Awaiting review by FRB*
8. *PP - Awaiting disposition*

APPENDIX F

The Least Squares Fit

Whenever a collection of experimental data points are obtained as a function of some independent variable, and the data does not follow a clear deterministic formula, it is often desirable to make a scatter plot of the data. The plot usually shows the general trend of the data and suggests what type of a curve would be most appropriate to represent the experimental results. The problem then is as follows:

Given the collection of data points y_i, $i = 1, \ldots N$ each measured at independent variable x_i, $i = 1 \ldots N$ and a curve described by a formula

$$f = f(x; a, b, c, \ldots) \tag{1}$$

where a,b,c,... are the parameters that define the curve f, how should one select the parameters a,b,c, etc. to make the best fit to the data?

In order to solve this problem, it is necessary to specify what is exactly meant by the best fit. One criterion of the best fit is to add all distances from the experimental data points to the curve and to minimize the sum of these distances. This intuitively appealing criterion is easy to formulate, but difficult to treat mathematically. However, a small change in it does make it readily tractable. If, instead of distances, one adds the squares of distances, the difficulty is alleviated considerably. To this end consider the function that is the sum of squared deviations from the curve

$$E = \sum_{i=1}^{N} [y_i - f(x_i, a, b, c, \ldots)]^2 \tag{2}$$

In order to minimize E relative to the parameters a, b, c, etc. take the partial derivative with regard to each parameter and to set it equal to zero

$$\frac{\delta E}{\delta a} = -2 \sum_{i=1}^{N} [y_i - f(x_i, a,b,c, \ldots)] \quad \frac{\delta f(x_i)}{\delta a} = 0 \tag{3}$$

$$\frac{\delta E}{\delta b} = -2 \sum_{i=1}^{N} [y_i - f(x_i, a,b,c, \ldots)] \quad \frac{\delta f(x_i)}{\delta b} = 0 \tag{4}$$

$$\frac{\delta E}{\delta c} = -2 \sum_{i=1}^{N} [y_i - f(x_i, a,b,c, \ldots)] \quad \frac{\delta f(x_i)}{\delta c} = 0, \text{ etc.} \tag{5}$$

Note that there are as many equations as there are parameters in the formula for the curve f. The solutions to the above equations may represent not only the minimum, but also the maximum for E in (2). Since the equations (3), (4), (5), etc. represent the local partial derivatives, there may be more than one set of the local minima or maxima. Among them there is an absolute minimum but it may be difficult to locate it. This is particularly true in a non-linear case where one has to resort to numerical methods of solution.

The Trend Selection

The scatter plot of the experimental data usually suggests the type of curve that f should represent. However, in practice there may be more than one candidate for such a curve.
In such a case the above method can be used twice. First, each candidate curve is subjected to the equations (3), (4), (5), etc. and their solutions give the best fit parameters of each candidate curve. Then, the sum of squared deviations, as in Eq (2), is computed for each candidate and the results are compared. Whichever curve gives a lower value for E in equation (2) is the preferred candidate. However, it must be stated that the selection of the curve f or many such curves as candidates to explain the experimental data remains ultimately an arbitrary choice of the user of this method.

The Linear Case

The most frequently selected curve for f is the straight line

$$f = a + bx$$

with just two parameters. In this case there are only two equations. With

$$\frac{\delta f}{\delta a} = 1 \quad \text{and} \quad \frac{\delta f}{\delta b} = x$$

they are

$$\sum_{i=1}^{N} y_i = Na + b \sum_{i=1}^{N} x_i \qquad (6)$$

$$\sum_{i=1}^{N} y_i x_i = a \sum_{i=1}^{N} x_i + b \sum_{i=1}^{N} x_i^2 \qquad (7)$$

These are two linear equations in two unknowns a,b whose solutions depend entirely on the experimental data points y_i, x_i, and N.

When the candidate curve is a polynomial of degree n

$$f = a_n + a_{n-1}x + a_{n-2}x^2 + \ldots + a_0x^n \qquad (8)$$

There are n+1 parameter equations all of them linear in the parameters a_0, a_1, a_2 ... a_n, and therefore solvable by the well-known method of the inverse (square) matrix. For all other forms of the curve f, unless they can be recast into (8) by some coordinate transformations, the parameter equations are non-linear, and their solutions can be obtained only by the less desirable approaches such as various numerical methods.